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The National Locksmith

Guide to:

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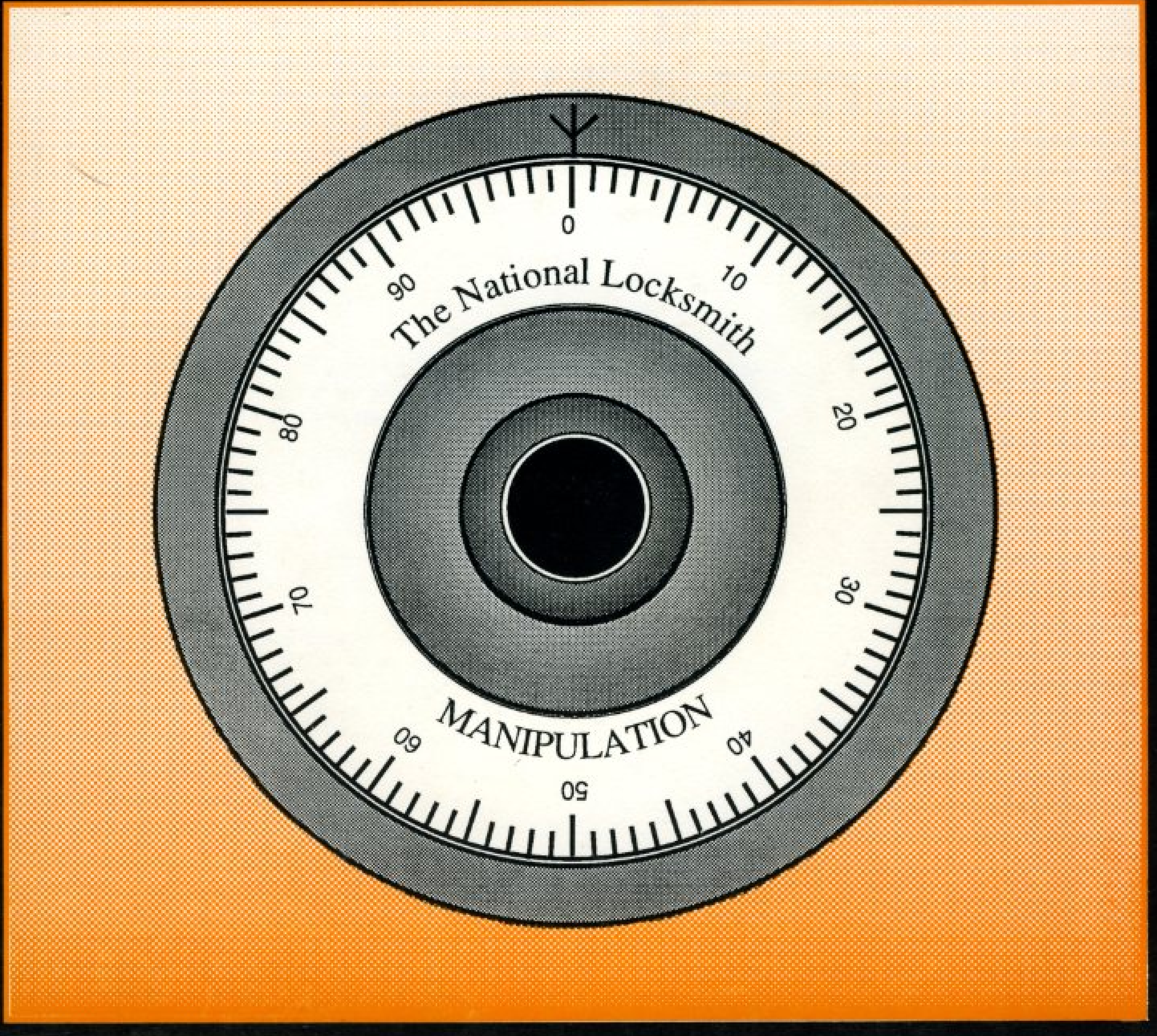
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The National Locksmith
MANIPULATION

by Robert Gene Sieveking

The National Locksmith®

Guide to:
M·A·N·I·P·U·L·A·T·I·O·N

by Robert Gene Sieveking

This book is written by a locksmith for locksmiths. It is not for sale or distribution to the general public, or to members of any trade other than locksmithing.

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I wish to give a very special thank you to Marc Goldberg. Without his faith and constant encouragement this book would never have been completed.

I wish to give a special thank you to my loving wife Jane. Her river of coffee and mountain of faith fueled the idea and made this book a reality.

R. G. Sieveking

DEDICATION

This book is dedicated to my late father. A craftsman in the truest sense of the word. A hard task master and a good teacher.

If you're going to do something, do it right.
If you're going to be something, be the best.

PREFACE

Bob Sieveking has completed an amazing task in writing this book on Manipulation. He has taken a complicated subject and he has broken it down and organized it into many steps which you may learn one step at a time. This may sound like an easy thing to accomplish. However, when considering a subject as complex as this one, the job of teaching becomes all the more difficult.

Yet the result of the author's labor is a book which is virtually a complete *course* on Manipulation. One would never expect to learn a subject just by paging through a book on the topic. For example, even an excellent book on French will not help you to speak French unless you practice and work hard. But if you exert yourself, follow the author's instructions, and practice, practice, practice...you *will* learn to manipulate combination locks. Taking an actual course will upgrade your skills even further.

As Editor and Publisher of *The National Locksmith* magazine, my work is centered on bringing information to the locksmith that will help you learn new skills. Locksmithing is becoming more and more a service-related industry. Therefore, it behooves the locksmith to have as many security-related skills as humanly possible. This makes your business more complete and will help you make more money in your career. Learning skills like Manipulation will help insure that you do not have to refer these calls away to other craftsmen. Thus your customer comes to understand that he can call you for service whenever he has a security problem.

The National Locksmith magazine publishes a line of books and manuals written by locksmiths for other locksmiths. This is such a book. Contained in this manual are techniques that have been passed from generation to generation of locksmiths. Be sure to use caution when storing this book. Guard it carefully to be sure that is does not fall into the wrong hands. I urge you to continue your quest for knowledge and understanding of the locksmith trade. Of course, you should subscribe to *The National Locksmith*. It is a very easy way to learn many new techniques and important information.

I would like to thank Bob Sieveking for his good work in writing this book. We believe that combination locks will play an important role in security for many, many years to come. Therefore, locksmiths will be referring to this book on Manipulation for generations to come. I am proud to have played a part in its publication. The author is to be highly commended. And you, the reader, are to be commended also...for seeking to upgrade your skills. Congratulations.

Marc Goldberg
Editor/Publisher

FORWARD

The purpose of this book is to give the reader a background in the art of safe manipulation that will allow him to manipulate a majority of the safes that would normally be drilled. Manipulation is no myth, and there are no deep dark secrets or special talents possessed by only a very few. The art of manipulation is simply a thorough knowledge of the lock and a proven method of defeating it with a light touch. Manipulation is the finesse that will open the most impressive security container without force or tools, leaving the container in the same condition that you found it. The security of the container and insureability of its contents is in no way diminished. By learning manipulation and becoming proficient in the art, you will earn the respect of your customers and be building your reputation as a craftsman.

In some shops, the standard practice for opening a safe when the combination has been lost or forgotten is to drill a hole through the door under or around the dial which enables the mechanic to destroy the lock or read the combination with a borescope. The hole must be drilled at a point where the manufacturer has reinforced the door with some of the most exotic materials available, materials engineered for maximum drill resistance. Once through the door, glass plate relockers, plates of ball bearings and even an occasional vial of tear gas await the unwary mechanic. In the name of expedience, the locksmith makes his way down a road fraught with difficulty. Even after the safe has been opened, the problems continue. The door must be removed and transported back to the shop for repair. The holes must be welded, the hard plate repaired, the lock replaced or repaired, fireproofing replaced, the door painted to match the safe and returned to the customer. After all this work, even the most proficient locksmith cannot certify the container as a fire safe. A drilled container loses its fire rating and insureability.

Although it may be necessary to drill from time to time because of mechanical failure or malfunction of the lock, a majority of the lockouts you will encounter can be solved by manipulation.

Manipulation is a scientific procedure that will bring together your knowledge of the locking device and your senses of sight, sound and touch with a simple method of reading indications given by most wheel type safe locks.

It is the intent of this author to give the reader a solid background in safe lock technology, a standard vocabulary of safe terminology, a working knowledge of the manipulation process and the benefit of experience gained from past openings. The chapters are divided into three parts. At the beginning of each chapter there is a learning objective or goal. Each chapter will contain illustrations and text which lead the student to the accomplishment of this goal. At the end of each chapter will be found study questions designed to test the readers comprehension of the material covered and reinforce some of the more important points. It has been said, "knowledge opens doors." Nowhere is this more true than in the art of safe manipulation.

Good luck.

NOTE

It is strongly recommended that the reader obtain a mounted, cutaway S&G or La Gard group 2 combination lock. Throughout the book we will be asking you to follow wheel action and perform various basic tests, manipulations and experiments. These locks are available from various suppliers and should be easy to obtain.

With the lock, you will be able to follow along as various manipulation techniques and concepts are presented. Through this "HANDS ON" technique, you will be better able to profit from the material as it is presented.

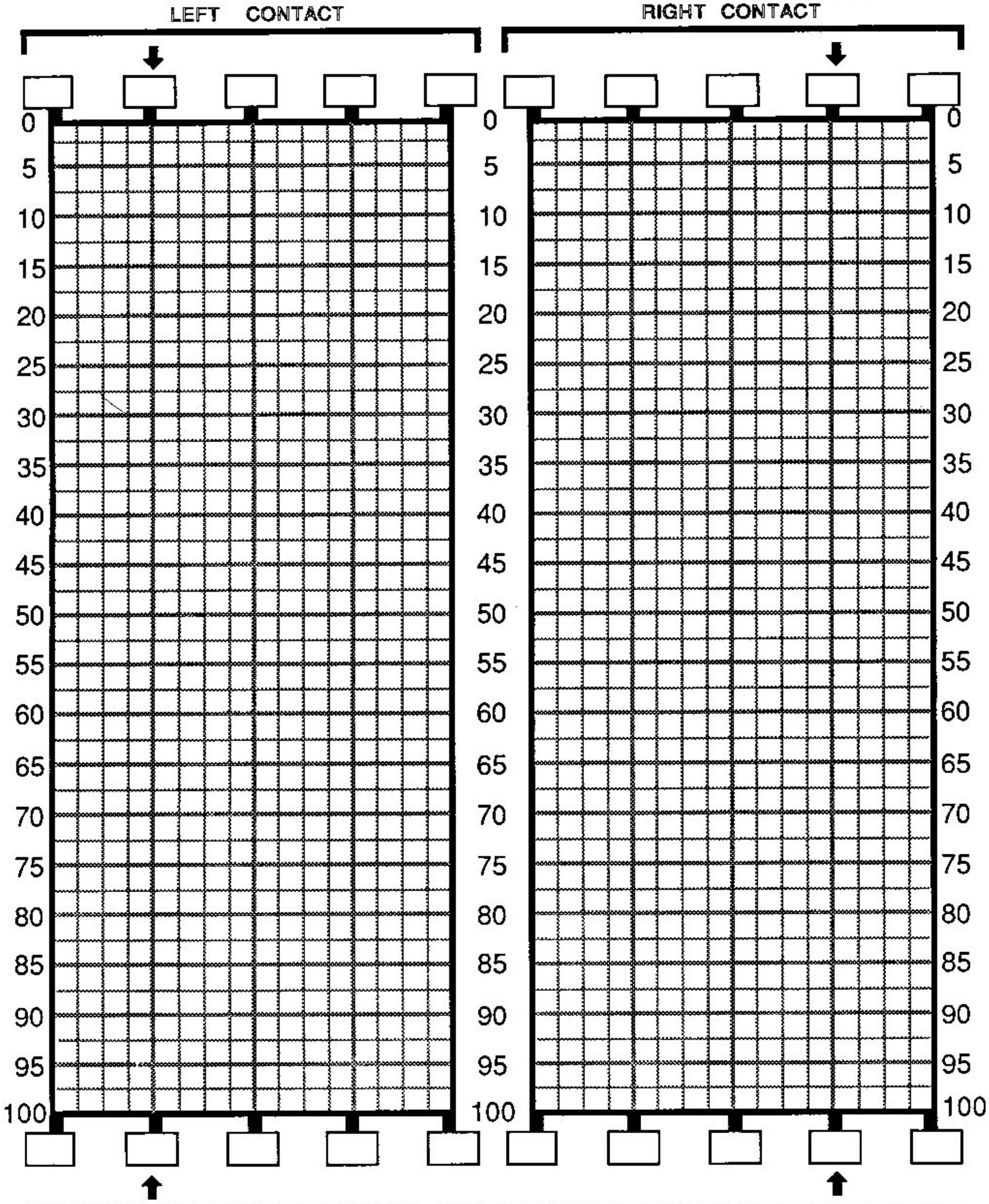
SPECIAL BONUS **FREE GRAPH SHEETS FOR LIFE**

The following page is a master of the graph sheet used in the text. Do not write on this page. It should be used to make copies for future manipulations. The trial combination sheets (2) are for three wheel locks and four wheel locks. Use the sheet that is correct for the lock you are manipulating. It is suggested that the graph be printed on one side of the sheet and the trial combinations be printed on the reverse side of the same sheet. If you use the masters for this purpose, they will last indefinitely.

COMBINATION LOCK GRAPH NO. ________ WHEEL ACTION 1 ____________

LOCK MANUFACTURER ______________________________ 2 ____________

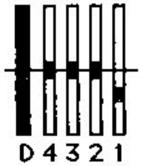
DATE ____________ REMARKS ______________________________ 3 ____________



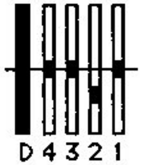
(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	WHEEL #4 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1							
2							
3							
4							

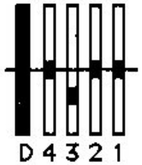
TEST COMBINATIONS



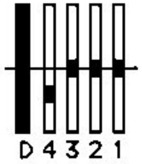
① Turn_____ 5 times to ______
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.



② Turn_____ 5 times to ______
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.



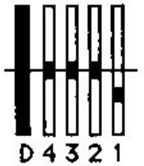
③ Turn_____ 5 times to ______
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.



④ Turn_____ 5 times to ______
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	WHEEL #4 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1							
2							
3							
4							

TEST COMBINATIONS



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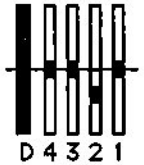
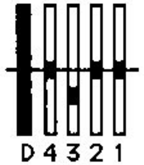
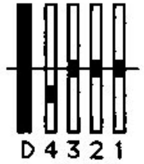
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.



② Turn_____ 5 times to ______
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.



③ Turn_____ 5 times to ______
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.



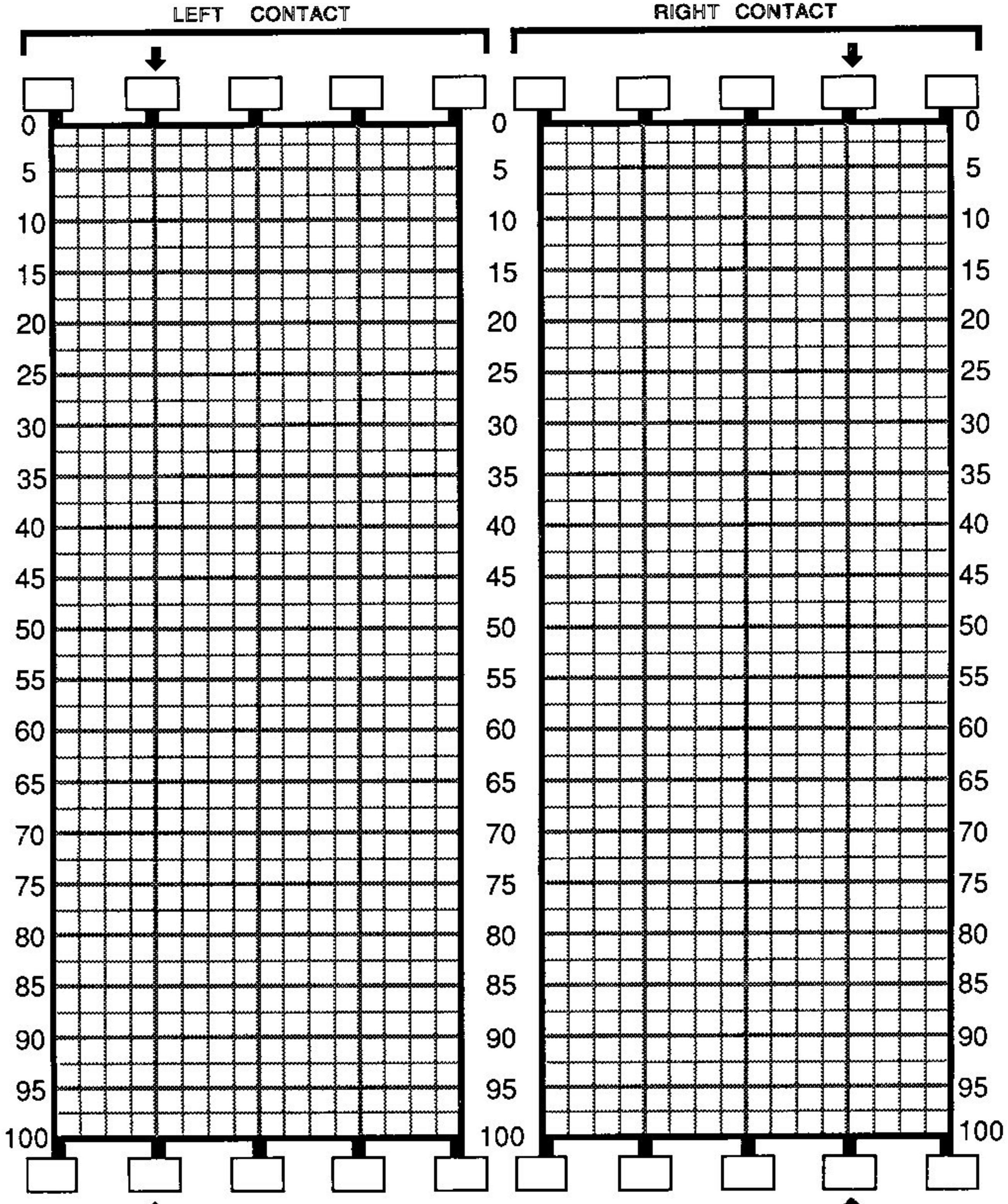
④ Turn_____ 5 times to ______
Turn_____ 4 times to ______
Turn_____ 3 times to ______
Turn_____ 2 times to ______
Turn_____ to contact area,
read contact points.

GATE CENTER__________________ CONCLUDE__________________
HIGH TEST NUMBER______________ __________________
LOW TEST NUMBER______________

COMBINATION LOCK GRAPH NO. ______ WHEEL ACTION 1 __________

LOCK MANUFACTURER __________________ 2 __________

DATE __________ REMARKS __________________ 3 __________

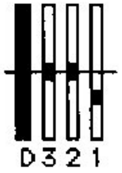

LEFT CONTACT
RIGHT CONTACT
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	▨					
2		▨				
3			▨			

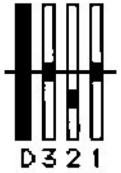
TEST COMBINATIONS

①



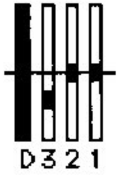
Turn _____ 4 times to _____
Turn _____ 3 times to _____
Turn _____ 2 times to _____
Turn _____ to contact area,
read contact points.

②



Turn _____ 4 times to _____
Turn _____ 3 times to _____
Turn _____ 2 times to _____
Turn _____ to contact area,
read contact points.

③



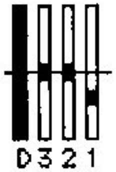
Turn _____ 4 times to _____
Turn _____ 3 times to _____
Turn _____ 2 times to _____
Turn _____ to contact area,
read contact points.

GATE CENTER _____________
HIGH TEST NUMBER _____________
LOW TEST NUMBER _____________

wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	▨					
2		▨				
3			▨			

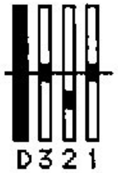
TEST COMBINATIONS

①



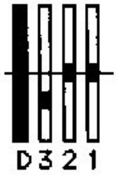
Turn _____ 4 times to _____
Turn _____ 3 times to _____
Turn _____ 2 times to _____
Turn _____ to contact area,
read contact points.

②



Turn _____ 4 times to _____
Turn _____ 3 times to _____
Turn _____ 2 times to _____
Turn _____ to contact area,
read contact points.

③



Turn _____ 4 times to _____
Turn _____ 3 times to _____
Turn _____ 2 times to _____
Turn _____ to contact area,
read contact points.

CONCLUDE _____________

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Chapter One

Safe Lock Identification

SAFE LOCK IDENTIFICATION

A basic vocabulary of safe terms and terminology.
An introduction to four basic fence types.
First understanding of wheel action.

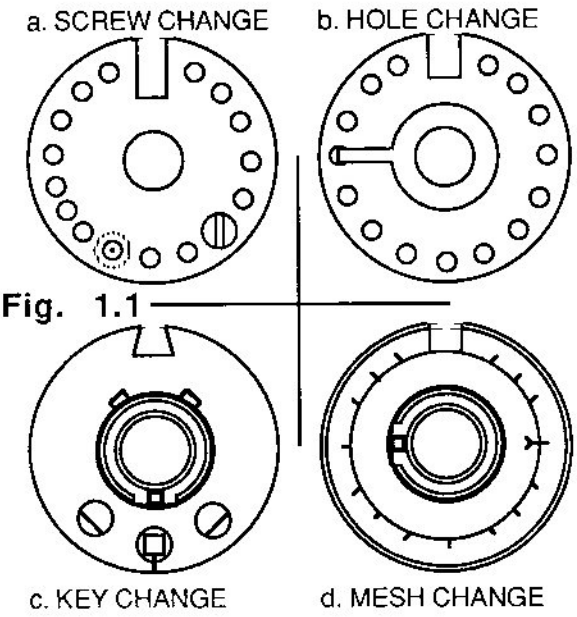
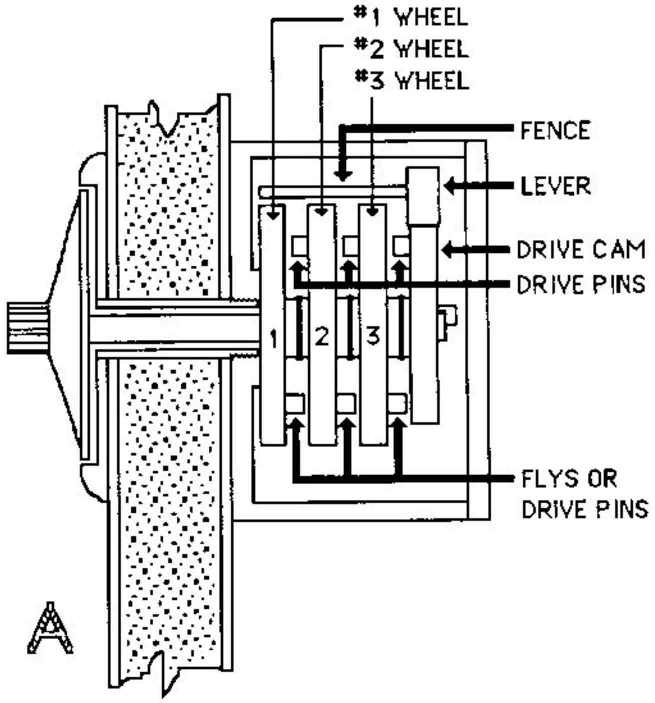
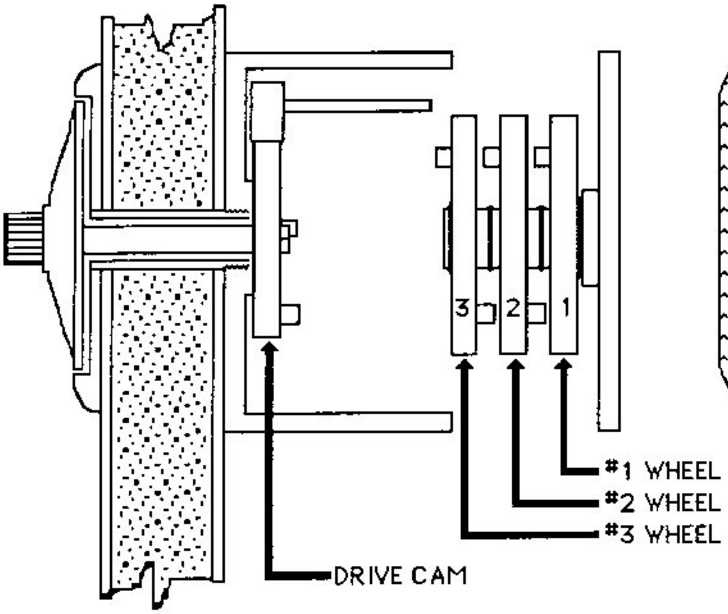
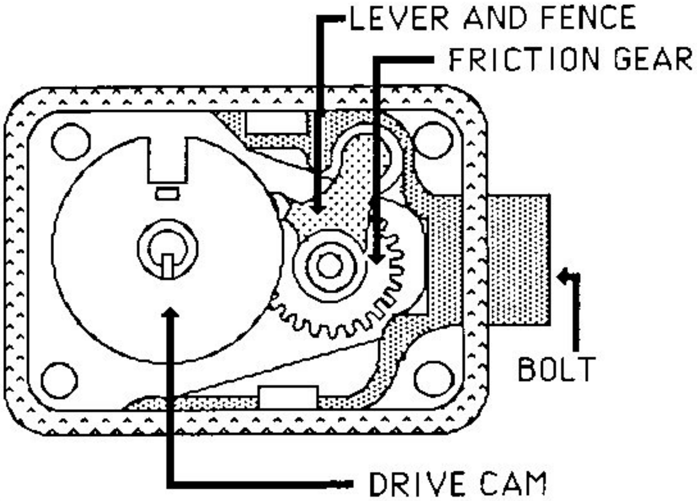


Fig. 1.1

a. SCREW CHANGE
b. HOLE CHANGE
c. KEY CHANGE
d. MESH CHANGE


#1 WHEEL
#2 WHEEL
#3 WHEEL
FENCE
LEVER
DRIVE CAM
DRIVE PINS
1
2
3
FLYS OR DRIVE PINS
A


3
2
1
#1 WHEEL
#2 WHEEL
#3 WHEEL
DRIVE CAM


LEVER AND FENCE
FRICTION GEAR
BOLT
DRIVE CAM

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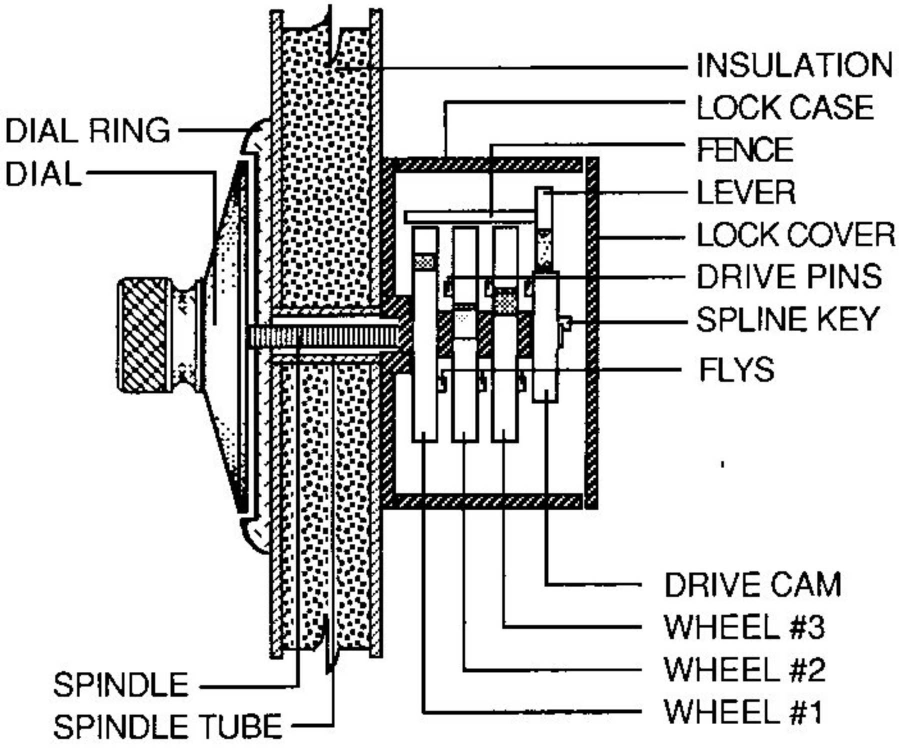
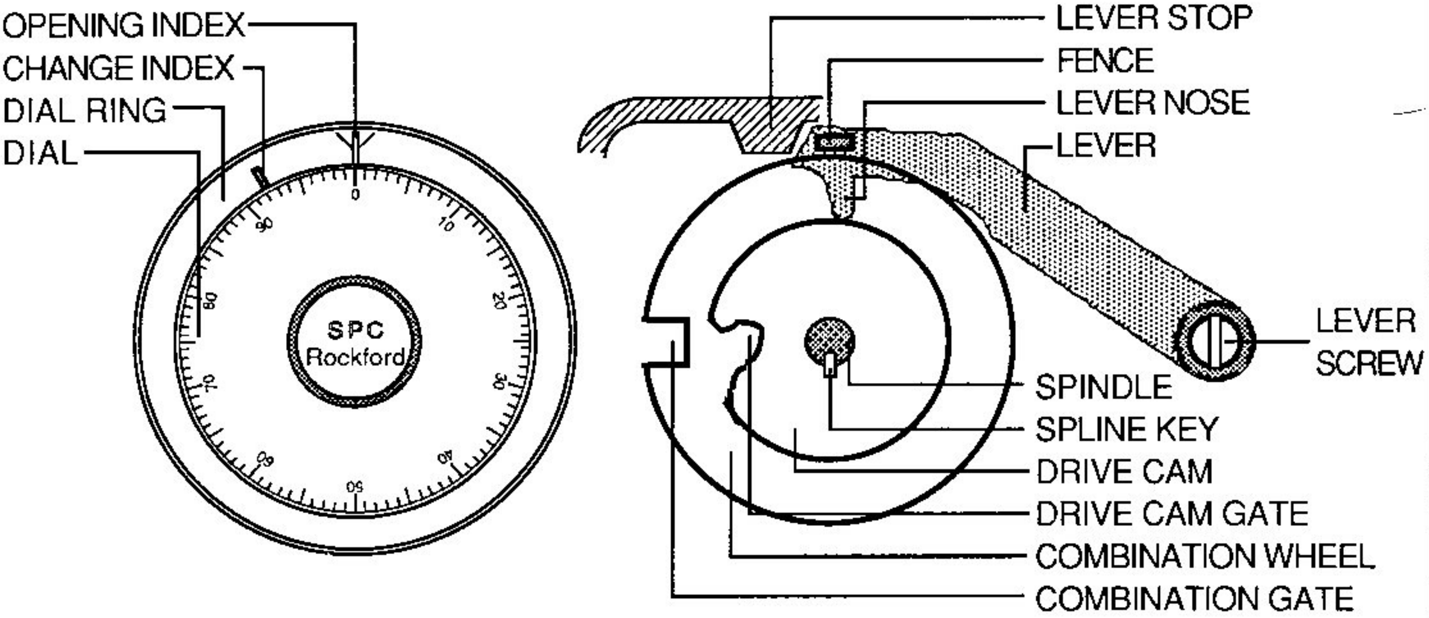
E-1

The wheel lock, cut-away view


INSULATION
LOCK CASE
DIAL RING
FENCE
DIAL
LEVER
LOCK COVER
DRIVE PINS
SPLINE KEY
FLYS
DRIVE CAM
WHEEL #3
WHEEL #2
WHEEL #1
SPINDLE
SPINDLE TUBE

E-2

The wheel lock, front and rear views.


OPENING INDEX
CHANGE INDEX
DIAL RING
DIAL
0
10
20
30
40
50
60
70
80
90
SPC
Rockford
LEVER STOP
FENCE
LEVER NOSE
LEVER
LEVER SCREW
SPINDLE
SPLINE KEY
DRIVE CAM
DRIVE CAM GATE
COMBINATION WHEEL
COMBINATION GATE

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Safe Lock identification

Goals:

1. Upon completion of this chapter, you will have gained a basic working vocabulary of safe and safe lock terms and terminology.
2. Upon completion of this chapter, you will have a solid working knowledge of the wheel lock.
3. Upon completion of this chapter, you will be able to identify the major types of safe locks without opening the safe. (Locks will be identified by fence type.)

VOCABULARY

Refer to illustrations "E-1" and "E-2"

The **dial** is the round disk that allows the operator to rotate the combination wheels of the safe lock. The disk is divided into equal increments around its perimeter and calibrated either numerically or alphabetically. When used with the opening index of the dial ring, these calibrations allow the accurate positioning of the combination wheels of the wheel lock. In some cases the dial may be used to retract the lock bolt.

The **dial ring** is the round disk permanently attached to the safe door immediately behind the safe dial. The opening index is engraved on the dial ring and allows the combination wheels to be placed, with the use of the calibrations on the dial, in a position to open the safe. The dial ring may also have a change index. This allows the wheels to be placed in a position to allow a change key to be inserted to change the lock combination. A service index may be encountered on some locks. The combination must be dialed to the service index to remove the lock cover and wheel pack.

The **spindle** is the threaded rod which extends from the rear of the dial, through the safe door, and is fixed to the drive cam. The spindle transmits positional information to the drive cam from the dial. The spindle is threaded to allow its length to be accurately adjusted. There is a keyway in the shaft which allows the drive cam to be keyed to the spindle.

The **spindle tube**, used primarily in fire containers, extends from the front of the lock to the rear of the dial. It shields the spindle shaft from the insulation material used in the safe door. The spindle tube may be a part of the lock case and be keyed to the dial ring. In this case the spindle tube is used to maintain alignment of the lock to the dial ring. The spindle tube may incorporate a bearing for the dial to establish the alignment of the dial, dial ring and lock case.

The **drive cam** is the metal disk which transmits mechanical positioning information to the wheel pack and in some cases retracts the lock bolt. The drive cam is threaded to accept the spindle shaft and keyed so that it may be locked in a given position with reference to the dial. The drive cam may have multiple keyways. This allows the lock to be mounted in different positions while maintaining the drop-in at a given numeric value. (i.e., Whether the lock be mounted "Vertical-up," "Vertical-down,""Left hand" or "Right hand," the drop-in will be at "0.")

The **spline key** is a small flat metal key that fits into the keyway of the spindle shaft and drive cam, locking them together as one mechanical unit. In order to maintain proper mechanical alignment and reliable operation of the safe lock, the spline key should be tight in the keyway.

Drive pins are the fixed pins on the drive cam and combination wheels that, with the flys, couple the rotation of the dial to the combination wheels.

Flys are moving drive pins, found only on the combination wheels. When contacted by the drive pins they are free to move around the combination wheel by exactly "their width plus half the width of the drive pin." This makes it possible to dial a combination either left or right with the same numbers. (i.e., With the gate of a combination wheel set at left 20, right rotation of the dial to 20 will bring the gate to the same mechanical position with reference to the fence.) The fly allows numbers of the combination to be set close together. Without flys, a margin of five to ten numbers must be left between adjacent numbers of a combination. Not all combination locks have flys.

Figure 1.1 shows four types of combination wheels, two with and two without flys. Figures 1.1a and 1.1b of the illustration have fixed drive pins. Figures 1.1c and 1.1d have moving drive pins, or flys.

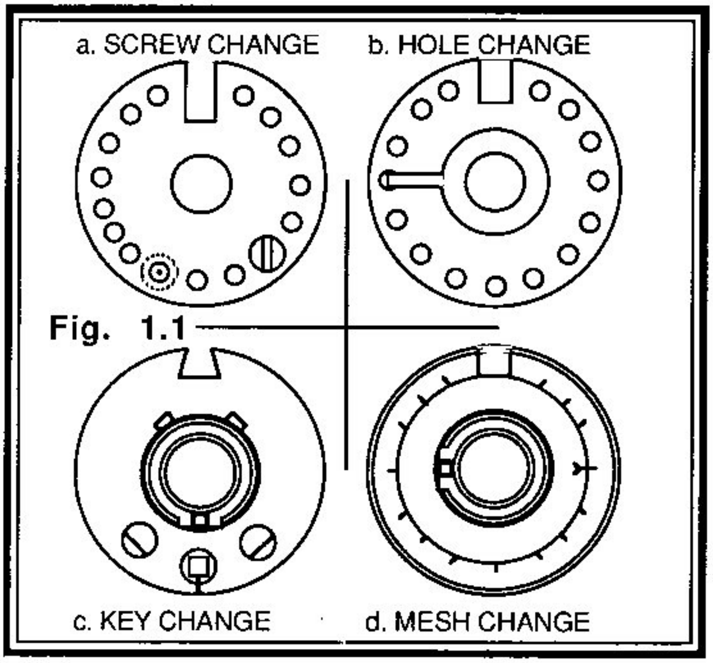

Fig. 1.1

The **combination wheel** is a round disk in the wheel lock that has a notch or gate in its edge. The angular position of the combination wheel, with reference to the fence, is determined by the rotation of the dial. The angular displacement of the gate with reference to the drive pin or fly determines the combination number (position) required to bring the gate under the fence. Illustration "1.1a" is a screw change wheel. The position of the screw will determine the combination of this wheel. A safe using this type of wheel will have a limited number of combinations. Illustration number "1.1b" is a hole change wheel. The position of the "drive pin/spacer" will determine the combination of this wheel. Again the number of possible combinations is limited by the number of holes in the wheel. Illustration number "1.1c" is a key change wheel. The combination of this wheel is determined by the relative position of the center hub to the gated outer ring. The combination of this wheel may be changed by the use of a special change key, which releases the center hub from the outer ring, allowing it to turn freely. In this illustration a change key is inserted into the square wheel release hub and turned 90 degrees to release the outer ring. The outer ring is held in position by the key as the inner hub is positioned to a new combination by the driver. The change key is then turned 90 degrees back to its original position to lock the hub to the outer ring. The key change wheel can be set to any number on the dial without disassembling the lock. Illustration number "1.1d" is a mesh or hand change wheel. The combination of this wheel is determined by the relative position of the center hub to the gated outer ring. To change the combination of this wheel, remove the center hub and reassemble with the index (on the center hub) at the desired number on the outer ring. The mesh change wheel can be set to any number on the dial but the lock must be disassembled to change the combination.

It is the function of a combination wheel to either prevent the fence from entering the wheel pack or allow the fence to enter the wheel pack. A common safe lock will have three or four combination wheels. This group of combination wheels will be referred to as the wheel pack.

The **combination gate** is the notch in the edge of the combination wheel. The gate is wide enough to allow the fence to enter the diameter of the wheel. The gate is usually wide enough to allow the fence to enter at plus and minus one half division on the dial. The gate is also deep enough to allow the lever to bypass the lever stop and the nose of the lever to enter the drive cam. For a straight in type lock, the gate will be deep enough to allow the fence to enter the wheel pack and retract the locking bolts.

The **fence** (see fig. 1.2) is that portion of the lever that rests upon the wheel pack. It is the function of the fence to determine if the combination wheels have been properly positioned by the dial and either allow the lever to bypass the lever stop and retract the bolt or prevent the lever from bypassing the lever stop. All combination gates must be properly aligned under the fence to allow the bolt to be retracted.

BOLT, LEVER and FENCE

(SPRING LOADED)

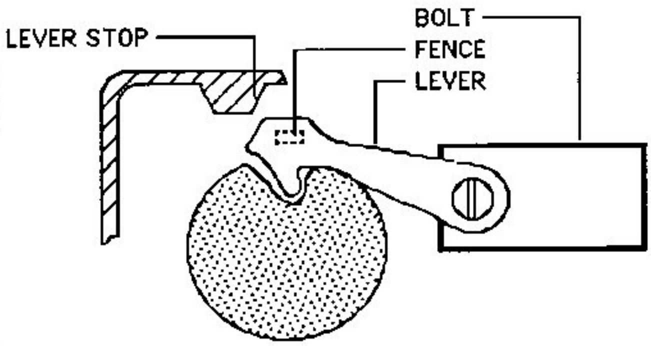

Fig. 1.2 (drive cam shown for clarity only)

The **lever** (see fig. 1.2) positions the fence over the wheel pack at a fixed point. When the proper combination is dialed, all combination gates will be centered under the fence. The lever, in some cases, also retracts the lock bolt. The lever is prevented from withdrawing the lock bolt by the lever stop or curb. The fence must allow the lever to fall far enough to bypass the lever stop before the bolt can be retracted. The nose of the lever rides on the edge of the drive cam and prevents the fence from contacting the combination wheels. At the drive cam gate the nose of the lever drops into the drive cam gate and the fence is allowed to either rest on or enter the wheel pack. The lever can be spring loaded against the wheel pack, gravity loaded or friction loaded, depending on the lock manufacturer.

The **lock bolt** (see fig. 1.2) is the bar which is extended or retracted from the lock case by the action of the dial. The bolt can be used to secure the safe door in the opening or it can be used to block the action of other bolts that secure the door. The lock bolt is dead locked in the extended position by the lever and lever stop.

****

This vocabulary should adequately equip the reader in his understanding of the following chapters. A thorough understanding of the working parts of the wheel lock and how they act on each other is absolutely essential if you are to defeat this lock. It is strongly suggested that the reader acquire an S &G or La Gard group 2, three wheel combination lock to study with this chapter. Mounted cut-away locks are available that will allow you to study the wheel action and observe the movement of the various internal components of the lock.

As we begin to study the operation of the wheel lock, we must logically divide the mechanism into three interactive groups. These are the:

1. "**DRIVER**"(dial, spindle and drive cam).
2. "**WHEEL PACK**" (combination wheels, drive pins and flys).
3. "**BOLT**" (fence, lever and bolt).

In the simplified diagram (fig. E-1) the spindle extends from the rear of the dial, through the safe door and wheel pack and is threaded into the drive cam. The spline key locks the drive cam in position on the spindle shaft. Note that these four components are now locked together as one mechanical unit. They rotate within the lock but do not change in their mechanical relationship. This group will be considered the "**DRIVER**," because its movements position all other components of the wheel lock. The driver will position each wheel in turn and ultimately retract the lock bolt. (See fig. 1.3.)

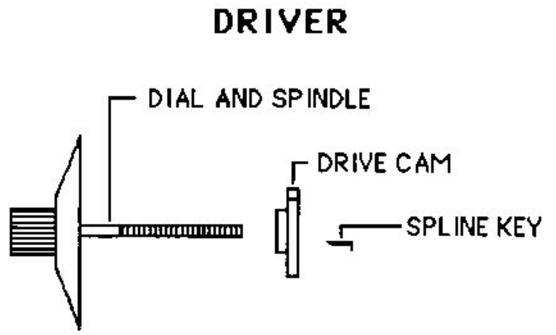

Fig. 1.3

The next logical group we must consider is the "**WHEEL PACK.**" (See fig. 1.4.) The wheel pack is comprised of combination wheels, drive pins and flys and is mounted on the wheel post. The wheels are free to turn independently on the wheel post. They are separated by isolation washers which prevent adjacent wheels from touching and "carrying around" as the combination is worked. The wheels are under spring tension supplied by the tension washer and are held on the wheel post by a retainer clip (spirolox, formed wire retainer or "E"ring). The tension on the wheel pack prevents the wheels from being vibrated. (Manipulation by vibrating the door or driver has been used to move the wheels around in a random fashion, the object being to bring the gates under the fence. As a gate

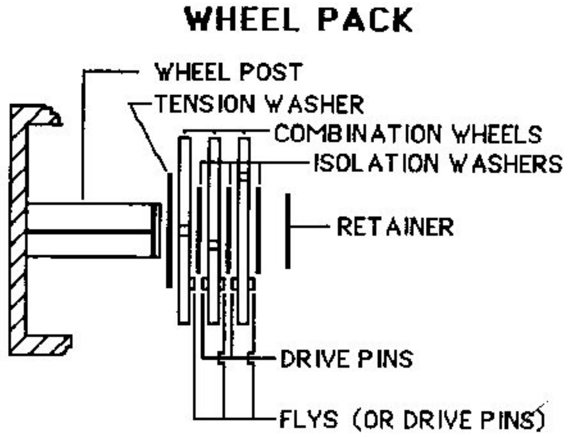

Fig. 1.4

passes under the fence, the fence drops and prevents that wheel from turning. Successive gates are captured under the fence by reversing the direction of the vibrating force and the safe is opened.)

To explain the operation of the wheel pack it will be necessary to examine the **wheel action**. Wheel action is the sequence of mechanical actions required to position each combination wheel, in turn, under the fence. A thorough understanding of the wheel action (i.e., what is happening inside the lock as we rotate the dial), will enable us to move and position wheels independently. It will also help when we begin to interpret indications obtained during the manipulation process. Like "X-RAY VISION," understanding of the wheel action allows the manipulator to visualize which wheels are moving and which wheels are not, during any part of the manipulation process.

The wheels of the wheel pack are numbered one, two and three. They are numbered according to the order in which they are positioned as the combination is dialed. The number three wheel is always the wheel closest to the drive cam. The number one wheel contains the first number of the combination, and must be properly positioned before the second number can be dialed. The number two wheel contains the second number of the combination, and must be properly positioned before the third number can be dialed.

Let us examine the wheel action using the diagram. (See fig. 1.5.) In the diagram assume the dial to be at 50. As we rotate the dial in a clockwise direction (right), the drive pin of the drive cam will approach the fly of the number three wheel. For simplicity of explanation we will say that at zero the drive pin of the drive cam will contact the fly of the number three wheel.

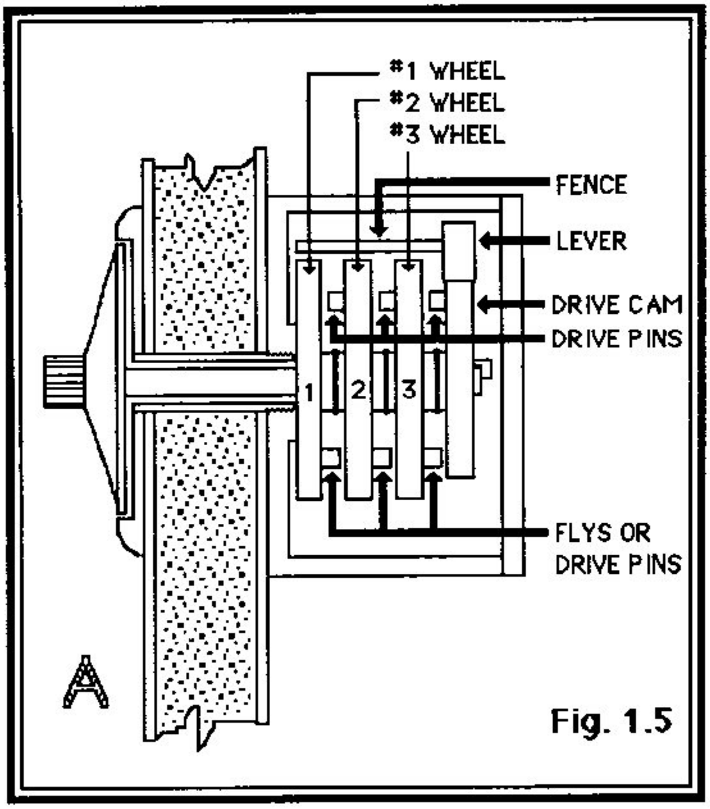

Fig. 1.5

In reality, the drive pin of the drive cam would have contacted the fly of the number three wheel at about 10 on the dial. After contacting the fly, the drive pin would have carried the fly around, without moving the wheel, until it picked up the number three wheel at zero (0). Further clockwise rotation of the dial would move or carry the wheel around right. If the lock was of the fixed drive pin type, there would be no lost motion after the drive pin made contact.

Further rotation of the dial in a clockwise direction will cause the drive cam to carry the number three wheel around right. As we approach 50, the drive pin of the number three wheel will contact the fly of the number two wheel. As we pass 50, the number two wheel will begin to move in a clockwise direction, being carried around by the number three wheel and the drive cam. As we continue to rotate the dial in a clockwise direction, we will pick up the number one wheel at zero. The drive cam is now driving all three wheels around right.

We will assume the combination of this lock to be: right 35, left 90, right 62. We will continue rotating the dial right, until the number 35 is directly below the opening index on the dial ring. This should place the combination gate of the number one wheel directly below the fence. Now we must reverse the rotation of the dial. As the dial is rotated counterclockwise (left) from 35, the drive pin of the drive cam must travel through 360° of rotation, before it will again engage the fly and move the number three wheel. As the dial reaches 35 the first time, the drive pin of the drive cam will contact the fly of the number three wheel. Further counterclockwise rotation of the dial will carry the number three wheel around left.

As we reach 35 the second time, the drive pin of the number three wheel will contact the fly of the number two wheel. Further counterclockwise rotation of the dial will carry the number two wheel around left. The second number of our combination is 90, so we will stop when 90 falls directly below the opening index of the dial ring. This should place the combination gate of the number two wheel directly below the fence and in line with the number one wheel. We now have two wheels properly positioned to open the safe. Reverse the direction of dial rotation. Turning the dial clockwise (right), the drive pin of the drive cam will contact the fly of the number three wheel as we reach 90 on the dial.

We are now ready to position the number three wheel. The third number of our combination is 62. Continue turning the dial in a clockwise direction (right),until the number 62 falls directly below the opening index of the dial ring. All three combination gates are now positioned directly below the fence. Counterclockwise rotation of the dial will bring the drive cam gate to a position below the nose of the lever, which will allow the nose to enter the drive cam gate. The combination gates of the combination wheels are all properly positioned to accept the fence. This will allow the fence to enter the combination wheels far enough to drop the lever below the lever stop. Further counterclockwise rotation of the dial will retract the bolt and allow the safe to be opened.

If any one of the combination wheels had not been properly positioned to accept the fence, the lever would have been prevented from falling below the lever stop and the bolt would have remained deadlocked in the extended position.

Study figures 1.5 and 1.6. You will observe that the drive cam of figure 1.5 is on the outside of the wheel pack, away from the dial. In figure 1.6 the drive cam is on the opposite side of the wheel pack and closer to the dial. Observe the numbering of the combination wheels. The number one wheel is always the wheel farthest from the drive cam and the number three wheel is always the wheel closest to the drive cam. Work through the wheel action again, using figure 1.6. The

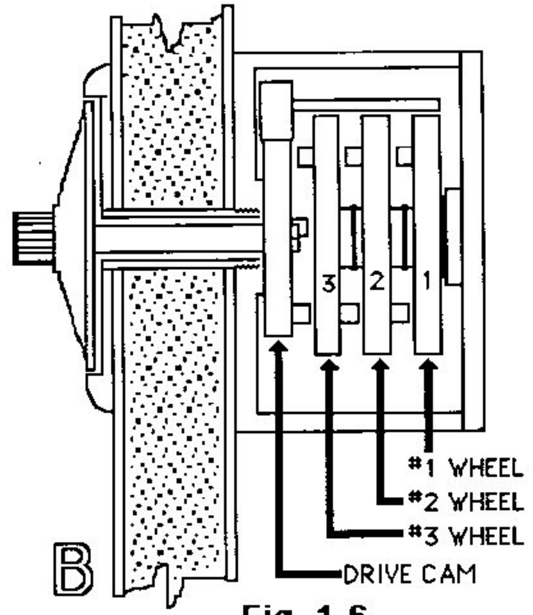

Fig. 1.6

wheel action is the same regardless of the position of the drive cam. The number one combination wheel always contains the first number of the combination and is the first wheel to be positioned. The number three wheel always contains the third number of the combination and is the last to be positioned.

The last mechanical group we will consider is the **fence, lever and bolt**. This group will be further divided into four major types. These are the spring loaded fence, friction fence, gravity fence and direct entry fence.

In the illustration of the spring loaded fence (fig. 1.7), it will be noted that the lever and fence are mechanically one piece. The lever is spring loaded to cause the nose of the lever to exert light pressure on the drive cam. As the drive cam is rotated to allow the nose of the lever to enter the drive cam gate, the fence will drop and cause the fence to rest on the wheel pack. (This is called the drop-in area.) If the proper combination has been dialed, the fence will enter the combination wheel gates and allow the lever to fall far enough to clear the lever stop. The nose of the lever will enter the drive cam gate, and further counterclockwise rotation of the dial will cause the lever to retract the lock bolt. If the proper combination has not been dialed, the fence will rest on the wheel pack. The lever will not fall far enough to clear the lever stop and the nose of the lever will not engage the drive cam to retract the bolt.

Figure 1.7 shows the function of the lever stop in preventing the bolt from being withdrawn by the drive cam and lever. You will also note that as the drive cam is rotated left and right in the drop in area, the nose of the lever will contact the drive cam on both sides of the drive cam gate. These points will be called the **"contact points.."** The distance between the contact points will be called the **"contact area."** The spring loaded fence may be identified by the presence of two contact points.

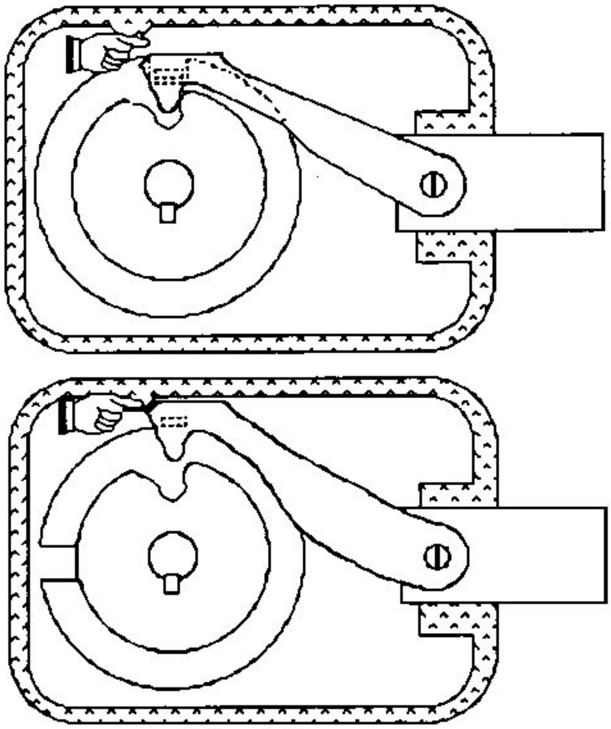

Fig. 1.7

The next type of fence, lever and bolt we should consider is the **friction loaded fence.** (See fig. 1.8.)

In the previous example the fence and lever were spring loaded, causing the fence to bear on the wheel pack as the nose of the lever entered the drive cam gate. Regardless of the direction of rotation, each time the drive cam gate passes under the nose of the lever, the fence will "try" the wheel pack.

With the friction loaded fence, there is no spring. The lever and fence only bear on the drive cam and wheel pack when the dial is rotated counterclockwise (left).

Note:

We are looking at the back of the lock in figure 1.8. The rear cover and wheel pack have been removed. Counterclockwise rotation of the dial causes the drive cam to rotate as shown.

The drive cam gear, mounted behind the drive cam, drives the fence gear around as shown. A friction clutch (the fence and lever are mounted on the fence gear post,under tension) causes the fence to "try" the wheel pack and drive cam. As the drive cam gate passes below the fence, the fence will "try" the wheel pack. If the combination gates are properly aligned at the drop-in, the fence will enter the combination gates and drive cam gate. The drive cam will then move the lever and fence to retract the bolt. If the combination wheels are not properly aligned, the fence will ride over the drive cam gate. One major difference in this lock over the spring fence is that there is only one contact point, and it is only experienced during counterclockwise rotation of the dial. Figure 1.8 is representative of the Yale 0C9. This lock and some special considerations concerning its manipulation will be discussed in a later chapter.

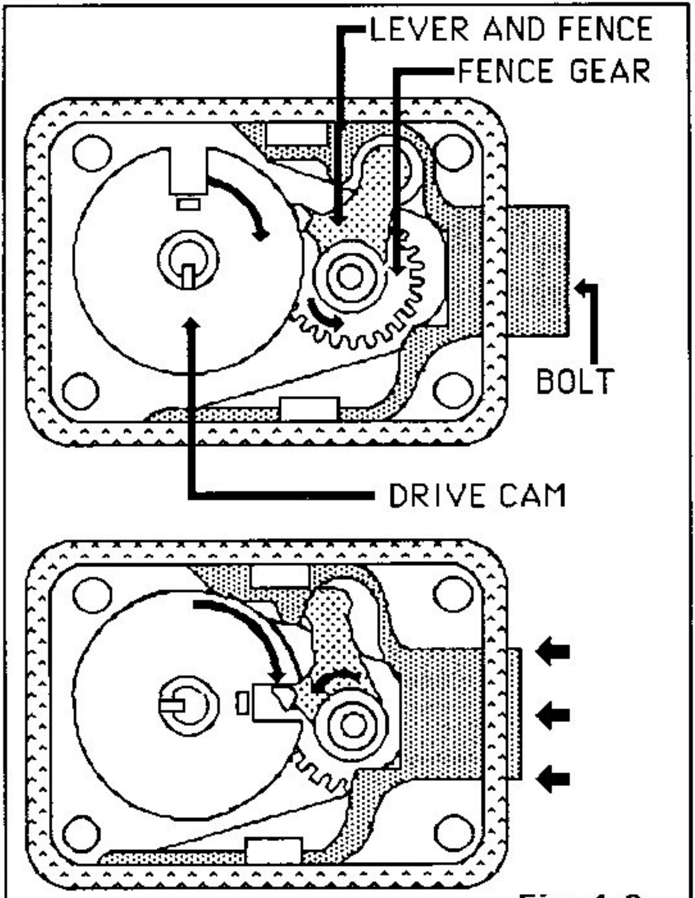

Fig. 1.8

The next type of fence, lever and bolt we will consider is the **gravity loaded fence.** (See fig. 1.9.) In the previous examples, the bolt was positively retracted and extended by the action of the driver. After dialing in the proper combination, the drive cam was positioned to accept the lever at the drop-in, and the bolt was pulled back by a positive mechanical action of the lever and drive cam. With the gravity loaded fence, the bolt is not pulled back but simply allowed to fall. The weight of the bolt on the pivot screw, levers the fence into the wheel pack. The only functions of the drive cam are to keep the fence from bearing on the wheel pack as the dial is rotated and to eject the fence. If the fence were allowed to rest or ride on the wheel pack as the dial were rotated, the combination could be gained by simply listening to the fence "click" as it rode over each combination gate, noting the position of each drop or "click" and dialing the possible combinations. This is not to say that listening for combination gates as the dial is rotated is not recommended. In some cases a high wheel will give away the position of its gate, which greatly simplifies the manipulation process, but locks are not designed to be manipulated that easily. It is not uncommon to find that some enterprising young locksmith has filed a number of false gates around the drive cam to confuse and frustrate the unwary thief (or manipulator).

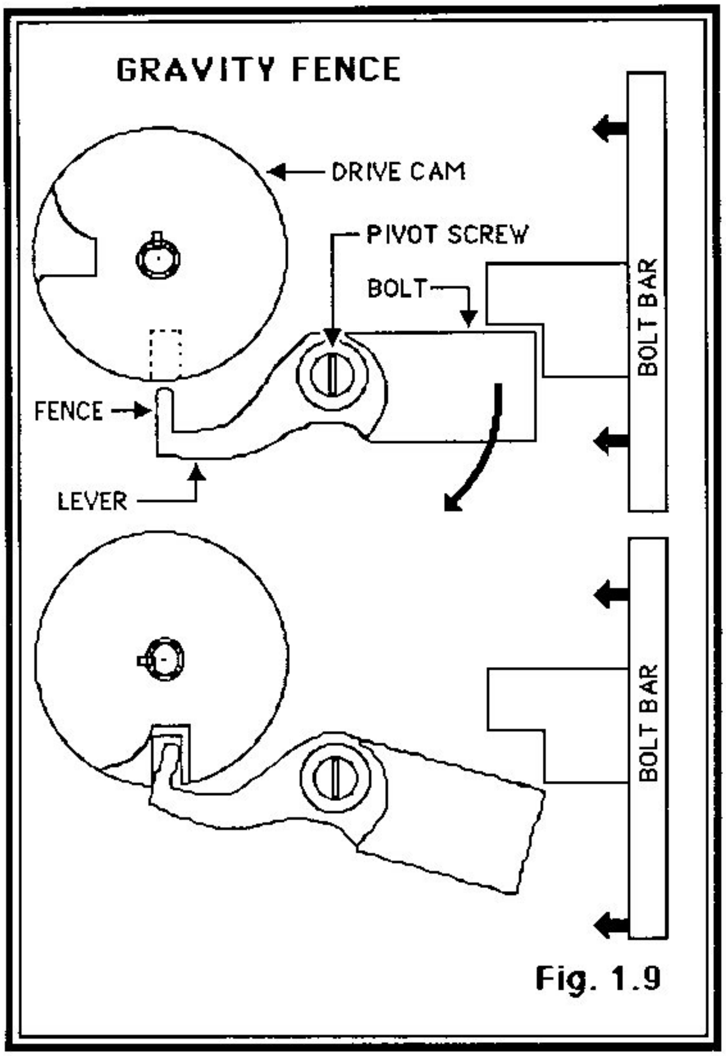

Fig. 1.9

Figure 1.9 shows the gravity fence lock in the locked condition. When the proper combination is dialed and the drive cam gate is positioned at the fence, gravity acting on the bolt will cause the lever, fence and bolt to rotate on the pivot screw as shown. The bolt will drop far enough to clear the blocker on the bolt bar and allow the door bolts to be retracted to open the safe.

This lock is easily identified by the bounce of the fence as the drive cam gate passes beneath it. That is, if the drive cam is rotated quickly through the drop-in area, the fence can be heard to jump or bounce on the drive cam if the bolt bar is not binding it. Another way to identify this type of fence is that the drive cam will sometimes bind if tension is placed on the opening handle.

☞ Note: Through wear in the lock and loose tolerances in the pivot it is sometimes possible to bind the wheels as the dial is rotated to reveal a combination gate. If a gate is found this way, it will probably be the number one wheel as it is farthest from the drive cam. Also, when false gates are encountered, measure the width of each gate using the dial. The widest indication will most probably be the true drop-in. Remember that the true drive cam gate must have a ramp on at least one side to eject the fence and position the bolt to lock the bolt bar. This ramp will give a softer indication than a straight sided false gate.

The last type of fence we will study is the **direct entry or straight-in fence.** (See fig. 1.10.) The direct entry type fence uses no lever or bolt. It is the simplest of the wheel locks in that the fence is an integral part of the bolt bar. The wheel pack directly prevents the door bolts from being retracted. In the previous examples, a lock bolt was extended or retracted to block or allow movement of the door bolts. Force applied to the opening handle was not coupled directly to the wheel pack. The direct entry type lock allows force to be applied directly to the wheel pack. If the proper combination has been dialed, and the drive cam is in position to receive the fence, turning the opening handle will cause the fence to enter the combination gates retracting the door bolts. If the proper combination has not been dialed, the wheel pack will directly prevent the door bolts from being retracted. The drive cam of the direct entry lock will almost always contain false gates from the factory. These false gates are necessary to prevent reading of the combination gates by warping the fence (by forcing the opening handle) while turning the dial. These false gates act to trap or prevent rotation of the drive cam when pressure is applied to the opening handle. Because these locks are usually found on less expensive fire containers, it is not unusual to find only two combination wheels and a drive cam. This will give a three number combination if the drive cam is counted.

This lock may be identified by the presence of "no" contact points and free rotation of the dial with no tension applied to the opening handle. When tension is applied to the opening handle, rotation of the dial will cause the drive cam to bind or turn hard. The false gates will allow the fence to enter far enough to block rotation of the drive cam.

DIRECT ENTRY FENCE

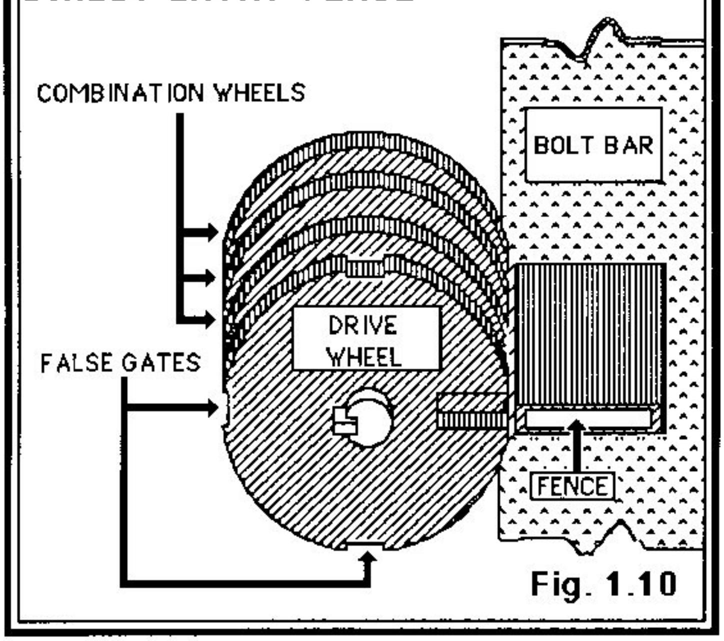

Fig. 1.10

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There are many variations on the basic design of wheel locks found in safes currently in use today. Here we have tried to give a basic overview of the most common types. Each of the listed fence types lends itself to a slightly different method of manipulation. By recognizing the fence type, and identifying the lock, you will be able to begin the manipulation with the method best suited to the lock at hand.

*

STUDY QUESTIONS

The following questions are to test your understanding of the material covered and reinforce some of the more important points.

1. What are drive pins?

2. What is the difference between drive pins and flys?

3. Name two types of combination wheels that will normally not have flys.

4. The wheel lock may logically be divided into three mechanical groups. Name these groups.

5. The combination wheel closest to the drive cam would contain which number of the combination? (first, second or third)

6. The combination wheel farthest from the drive cam always contains the last number of the combination. (true or false)

7. The fence, lever and bolt group may be categorized into four major types.
Name the four major types.

8. What are contact points?
What is the contact area?

9. When the Yale 0C9 lock is encountered, how many contact points would you expect to find?

10. You have encountered a safe lock that seems to have no contact points as the dial is rotated clockwise (right). When the dial is rotated counterclockwise, only one contact point can be found.
What type of lock have you encountered?
What is the fence type?

11. You have encountered a safe lock that seems to have no contact points, regardless of the direction of dial rotation.

You further discover that if you apply turning pressure on the opening handle, the dial binds and hangs up, preventing the dial from turning. Releasing the handle tension allows the dial to turn freely.
What type of lock have you encountered?
What is the fence type?

12. Describe the function of the fence in a wheel lock.

13. The lever performs two major functions in the spring loaded fence type lock.
What are the two major functions?

14. What is the function of the driver?

15. What is the function of the change index?

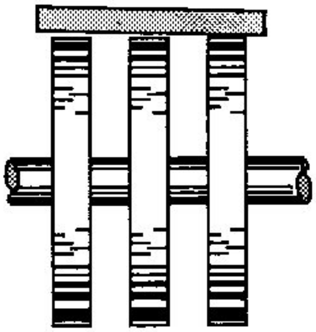
For study question answers, see page 133.

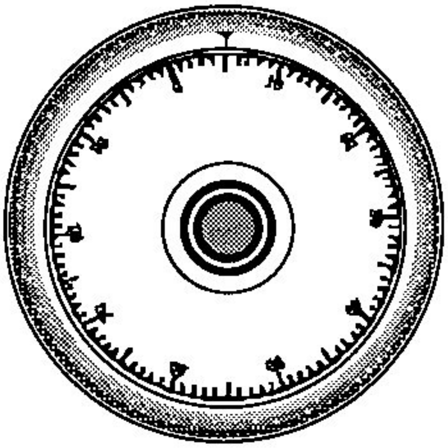
Chapter Two

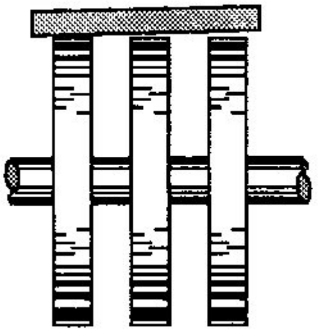
Principles of Manipulation

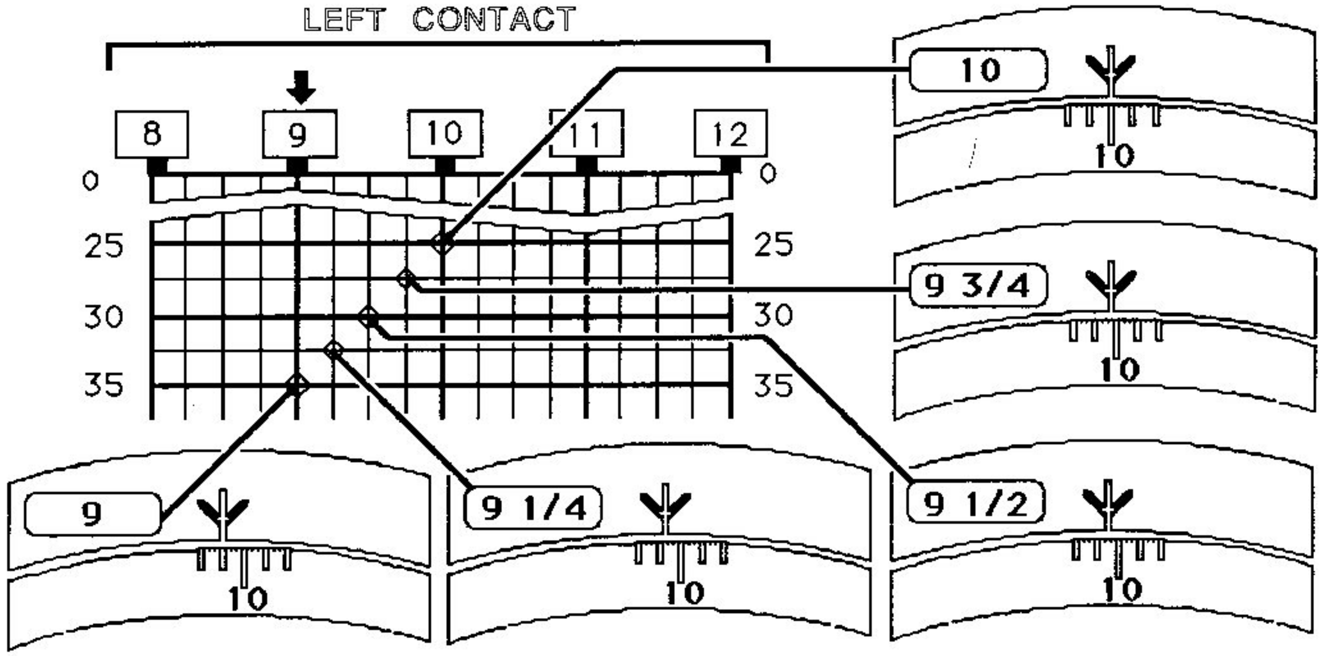
PRINCIPLES OF MANIPULATION

An introduction to manipulation principles.
Reading and recording contact points begun.
Where - What - and How to find indications.








LEFT CONTACT
8
9
10
11
12
0
25
30
35
10
9 3/4
9 1/2
9
9 1/4
10

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PRINCIPLES OF MANIPULATION

Goals:

1. Upon completion of this chapter, you will have gained a working knowledge of the mechanical principles that allow us to manipulate a combination lock.
2. Upon completion of this chapter, you will be able to determine the number of wheels in the combination lock without opening the safe.
3. Upon completion of this chapter, you will have gained a working knowledge of the proper method of determining the contact points and entering them on the manipulation graph.

INTRODUCTION

After completing the chapter ~~on~~ safe lock identification, you have a pretty fair idea of how a safe lock should work. This chapter will give you the tools. Tools that will allow you to determine if the lock can be manipulated, and if so how to properly begin the manipulation process.

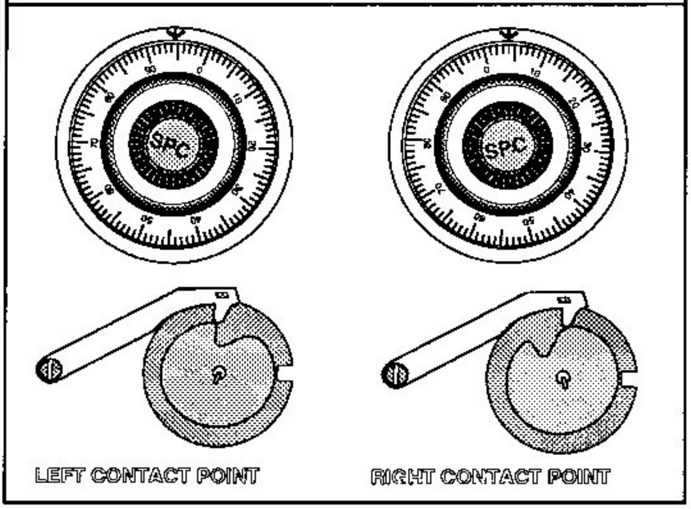
The first and most important step in any repair or trouble call is symptom recognition. This is the process of evaluating the conditions that exist, and comparing these to what would be considered proper operation of the lock. For the most part, this chapter will deal with locks in good working order. Follow this procedure using your cut away lock.

STEP ONE

In the first section of this chapter, you will begin the **manipulation of a spring fence type lock.** The first step in your manipulation will be to find the drop-in. Rotate the dial at least four times left, to pick up all wheels. Continue rotating the dial around left slowly, listening for the nose of the lever as it drops into the drive cam gate. As the nose of the lever comes off the drive cam the fence will drop, and rest on the wheel pack. Continue rotating the dial around left. The second indication will be the nose of the lever being struck by the right side of the drive cam gate. The drive cam will lift the lever, raising the fence above the wheel pack. Continue moving the wheel pack left, about ten numbers past the drop-in. Now reverse the direction of rotation and move the dial right until you return to the drop-in area. All the wheels of the lock have been carried around left, and are now "parked" ten numbers left of the drop-in. Oscillate the dial left and right in the drop-in to get a feel for the action of the lever in the drive cam gate. You should be able to hear the drive cam as it strikes the nose of the lever, at the left and right contact points, lifting the fence away from the wheel pack. As the nose of the lever drops into the drive cam gate you should hear the fence as it falls on the wheel pack.

Note: Grasp the dial with the slightest possible grip when reading the contact points. Your feel for the torque required to move the dial is very important. It should be **a sliding grasp that is just enough to move the driver in its bearings, but not enough to move or lift the lever as it comes into contact.** This will allow you to "place" the edge of the drive cam gate against the nose of the lever without moving the lever. As the manipulation progresses you must not vary in your touch. All readings must be taken with the same super-light touch. **Repeatability** is the key to accurate readings.

Fig 2.1



☞ Note: While in the contact area, if the dial is rotated right (clockwise) the left side of the drive cam gate will contact the nose of the lever. This will be called the LEFT CONTACT POINT. (See fig. 2.1a.)

While in the contact area, if the dial is rotated left (counterclockwise) the right side of the drive cam gate will contact the nose of the lever. This will be called the RIGHT CONTACT POINT. (See fig. 2.1b.)

The distance between the left and right contact points, as measured on the dial, will be called the CONTACT AREA.

Become familiar with the contact points and how they feel and sound. It is these contact points and the contact area that will allow you to open the lock.

In the previous exercise, you "parked" the wheel pack ten numbers left of the drop-in and tested the left and right contact points. Now rotate the dial left, away from the drop-in, about eight numbers. Further rotation will bring the drive pin of the drive cam into contact with the fly of the number three wheel, which will drive the wheel pack around left. Approach the number three wheel slowly, with a super light touch. You should be able to feel the drive pin contact the fly. Rotate the dial back right one or two numbers, and touch the fly again without moving it. With the friction of all three wheels, it should be easy to locate the position of the wheel pack without moving it.

STEP TWO

The second step in the manipulation will be to find the number of wheels in the lock. Rotate the dial left at least four times, to pick up all wheels. Since we have established the contact area, lets assume it to be between "0" and "10." Continue to move the wheel pack around left, and park the wheels at "50."

It is important to park the wheel pack well away from the drop-in for this operation to avoid confusing the drop-in with the pick up of the wheels. If the dial is binding at 50, you may park the wheel pack wherever is convenient, but try to stay as far away from the drop-in as possible.

Leave the wheel pack parked at left "50", and rotate the dial right to "70." Rapidly move the dial right, past "50" and stop. You should have heard and felt the drive pin of the drive cam as it contacted the fly of the number three wheel. This counts "one." Continue rotating the dial right to "70" again. Rapidly move the dial right, past "50" a second time. You should hear and feel the drive pin of the number three wheel as it contacts the fly of THE NUMBER TWO WHEEL.

Continue rotating the dial right to "70." Rapidly move the dial right, past "50" a third time. You should hear and feel the drive pin of the number two wheel as it contacts the fly of the number one wheel. This counts "three." Continue rotating the dial right, to "70." Again rapidly move the dial right, past "50" a fourth time. You should not hear or feel another wheel pick up, unless you have a four wheel lock. This counts "nothing." Always make four passes at the point where you have stacked the wheels. It is important to know if you have a three or four wheel lock in the first steps of the manipulation.

By stacking the drive pins at a known number, it is possible to approach the parked wheels from the opposite direction and count the wheels as they pick up. The dial is moved rapidly through the stack point because this makes the contact easier to hear. It is easier to hear the drive pin contact the fly if it strikes with a little force.

Though you worked through this step by parking the wheels at "all wheels left," it works equally well with all wheels parked at right "50." Reverse the procedure as follows:

1. Dial four turns right, to pick up all wheels.
2. Continue right, and park all wheels at right "50."
3. Dial left, to "70" and stop.
4. Rapidly left, past "50" Listen for wheel to pick up. Count this wheel "1."
5. Continue left to "70", and stop.
6. Rapidly left, past "50" Listen for wheel to pick up. Count this as wheel "2."
7. Continue left to "70" and stop.
8. Rapidly left, past "50" Listen for wheel to pick up. Count this as wheel "3."
9. Repeat steps "7" and "8" until all wheels have been picked up.

It is sound practice to inspect the drop-in and count the wheels each time you service a lock-out. (Many times this procedure will reveal the true cause of the lock-out. See service notes/flow chart, page 29) In the first two steps of the manipulation you have:

1. Located and tested the drop-in.
2. Tested the action of the lever and fence.
3. Counted the number of wheels.
4. Tested the drive pins and flys.
5. Determined whether or not to continue the manipulation.

STEP THREE

The third step in the manipulation process will be to take readings of the contact points and fill out manipulation graph number one. (A blank graph sheet is shown on page 27.)

As you begin taking readings of the contact points, remember that accuracy and consistency will determine your success or failure. Good lighting and a quiet environment are a must. Purchase a good quality fluorescent clamp base swing arm lamp. These lamps are available with a ring light and magnifier lens. Be sure that the magnifier lens is a quality "glass" lens, as the less expensive plastic lenses have distortion that will cause eye strain over the period of the manipulation. If you buy a cheap magnifier today, it will be a headache tomorrow. Magnifiers are available in from 1.75 to 6

Magnifiers are available in from 1.75 to 6 power. The 1.75 power magnification has proven to be the most serviceable, as it may be placed about ten inches from the dial to give a clear undistorted view of the dial and index. If more magnification is desired, lenses can be purchased separately. The clamp base swing arm will allow you to place the lamp in a comfortable position to view the lock.

INDICATIONS

Much like impressioning the pin tumbler lock, manipulation will allow us to use the lock to defeat itself. By knowing where to look for the tolerances in the lock and knowing how to read the indications they give, you will be able to "visualize" the combination wheels. By properly reading the indications, you will be able to locate the gates in the combination wheels and ultimately open the safe.

1. **Where do we look for indications?**
2. **What do these indications tell us of the lock?**
3. **How do we read and record the indications?**

WHERE ?

Where do we look for indications? As the dial is rotated through the contact area the nose of the lever slides down a slight incline to leave the fence resting on the wheel pack. As the dial is rotated further, the rounded nose of the lever is slid up another incline to raise the fence above the wheel pack. The two inclines which enclose the drop-in, at the drive cam gate, can be compared to a funnel. The deeper we go into the mouth of the funnel, the narrower it becomes. The same is true of the drive cam gate. The deeper the nose of the lever is allowed to enter the drive cam gate, the narrower the contact area will be. These inclines or ramps on either side of the drive cam gate are essential to the proper operation of the lock. Without the rounded sides of the gate, the nose of the lever would enter the gate and be trapped. These ramps are necessary to eject the lever when the bolt is extended. The sloped sides of the gate serve to amplify the indications given by the presence of a gate or low spot in the wheel pack. As the nose enters the gate by one increment, the gate narrows on both sides reducing the contact area by two increments or more.

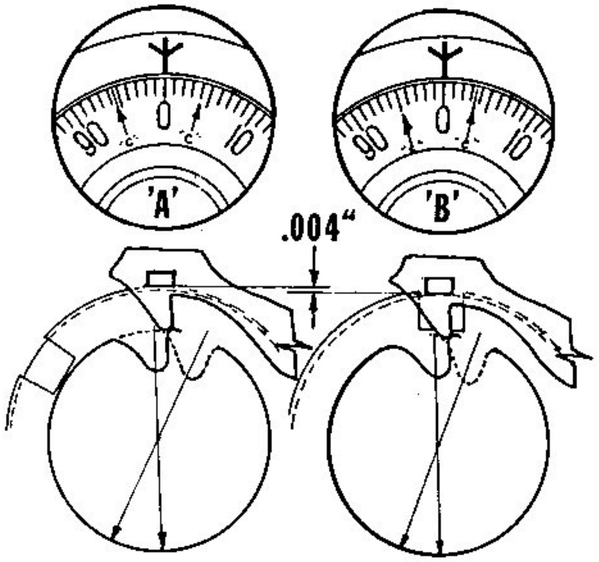


Fig. 2.2

In figure 2.2 you will see that the contact points (marked "c" at arrows on dial **A**) are "94 1/2" and "4." As the gate of the number three wheel is brought under the fence, the measured drop of the fence and lever is .004." Dial "**B**" of the illustration shows the resultant change in the contact points. The new contact points are "95" and "3 1/2." The contact area or distance between the contact points of the lock on the left (**A**) is "9 1/2" units. ("94 1/2" to "4") The contact area of the lock on the right (**B**) is "8 1/2" units. ("95" to "3 1/2")

These are actual measurements taken on a standard combination lock. You can easily see that a very small change in the diameter of the wheel pack will give a good indication in the width of the contact area.

TRY THIS LITTLE EXERCISE.

Slip a piece of paper under the fence of a combination lock in your shop, then check the contact area. Now remove the paper and check the contact points again. Now manipulate the wheels to place the combination gate of one wheel under the fence. Check your contact points. Do this for each wheel. Try it with two gates under the fence. The purpose of this exercise is to give you experience in reading contact points and confidence in the fact that the indications are there. The change in contact area will not always be as large as that of figure 2.2.

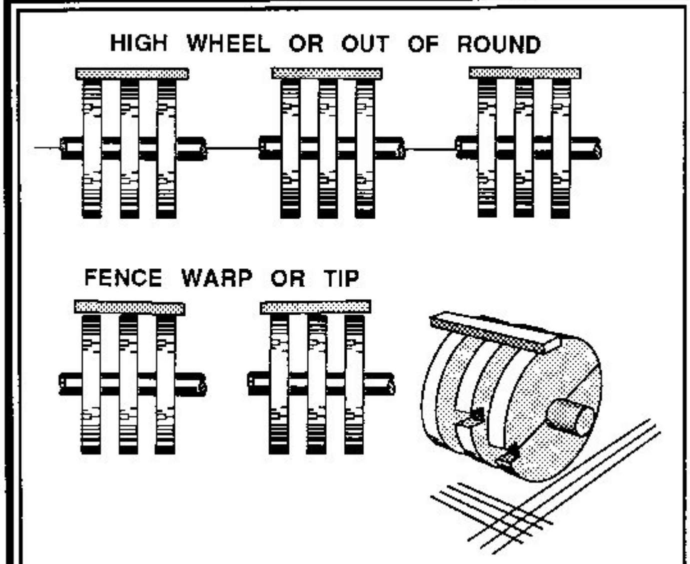


Fig 2.3

WHAT ?

Now that we have established a basic understanding of contact points and contact area, it will be necessary to understand what the indications are telling us of the lock. In the illustration on page 22, the number three wheel was the indicating wheel. This will not always be the case. Any of the combination wheels can be giving the indication of a low spot. Please note that the indication of a low spot in the wheel pack will not always be the indication of a combination gate. Figure 2.3 shows some common causes for the fluctuation in the width of the contact area. These tolerances can include: wheels of slightly different size, wheels that are not round, wheels that are not concentric with the wheel post,or a fence that is tipped or warped. It will sometimes be necessary to find a low spot in the wheel pack, then move one wheel at a time, around, before the indication of a gate can be found. A high spot on one wheel can "mask" the gates of the other wheels. A gate found in the low spot of one wheel may be "masked" by adjacent wheels. The indications are there, but sorting them out is sometimes more by guess than by indication. If it was easy, nobody would own a drill.

HOW ?

The dials illustrated in figure 2.4 have been enlarged to about 1.75 times their actual size to make them easier to read. In the illustrations you will note that the distance between "9" and "10" has been further divided into quarter number increments. Study the safe dials here to see how it is possible to "read between the lines." (Refer to fig. 2.4.)

9

On the first dial, the nine is perfectly aligned with the opening index.

9 1/4

On the second dial the left side of the opening index is perfectly aligned with the right side of the nine mark on the dial, showing "9 1/4." Use the edges of the engraved lines to align for quarter numbers.

9 1/2

On the third dial, the index is perfectly centered between the nine and ten marks on the dial, showing "9 1/2." Look for the centering of the index between numbers to see half numbers.

9 3/4

On the fourth dial the right side of the opening index is perfectly aligned with the left side of the ten mark on the dial, showing "9 3/4."

10

On the fifth dial we return to perfect alignment of the index above the ten mark on the dial. Now you know what a perfect ten looks like.

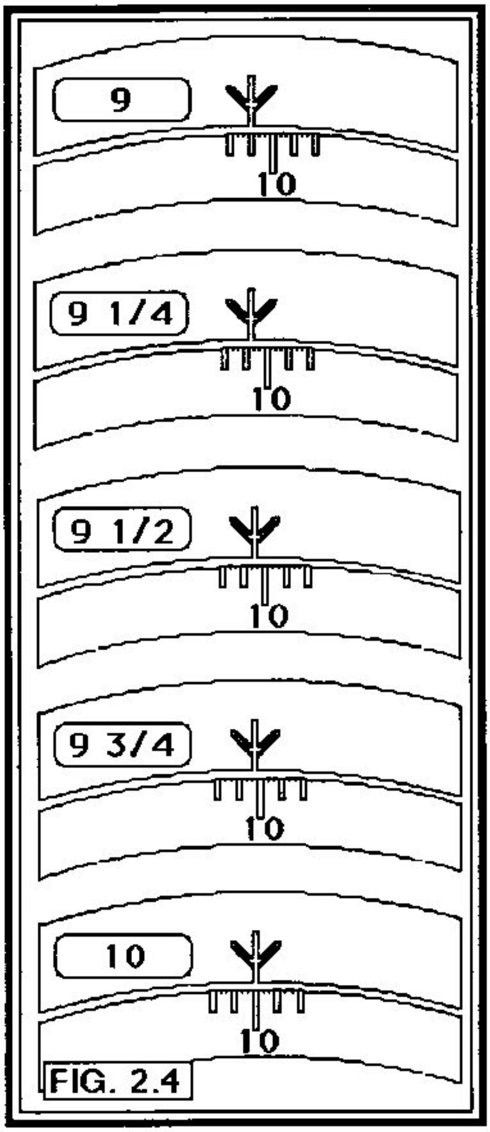


FIG. 2.4

Using the edges of the engraved lines works well with S&G spy ring dials and dials with wide lines. Angled dials like Yale, Mosler or Diebold have wider distance between the dial graduations, but judging quarter numbers should not be a problem if the dial is magnified. To make the engravings plainer, it is possible to use a lacquer stick to fill the lines. On a black dial with white letters, office type "white-out" paint applied with a tooth pick will brighten the graduations very nicely. Another trick that has been used with great success is to use a common hat pin. Bend the pin so that it will lay in the engraved line of the opening index and extend to the dial without touching the dial. Attach the pin flat on the face of the safe with a piece of tape. The fine point of the pin will make it possible to read the dial with more accuracy (paint the point of the pin with white-out to reduce the glare and increase the contrast of the point to the safe dial). Always read the dial from directly in front. The distance between the index and the dial can, if viewed off to one side or the other, cause your readings to be inaccurate. This is called parallax error.

There are many clever devices on the market that are designed to increase the readability of the contact points. Some may have real value, but all are more trouble than they are worth. A pin costs a penny and doesn't need batteries. It is possible to read eighths using the pin and magnifier. If the indications are less than an eighth of a division, the lock will probably not respond to manipulation.

Before we can begin an actual manipulation it will be necessary for you to understand the

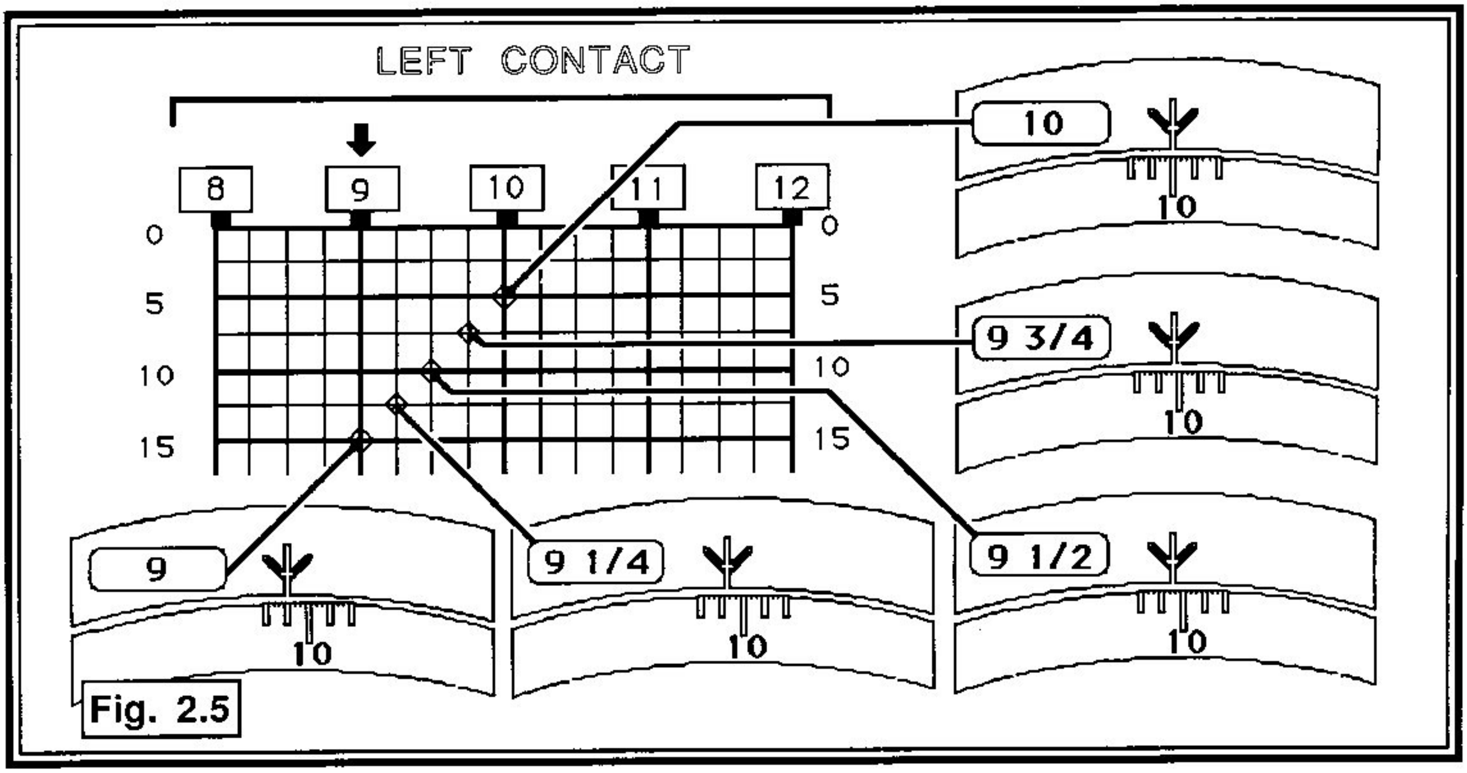
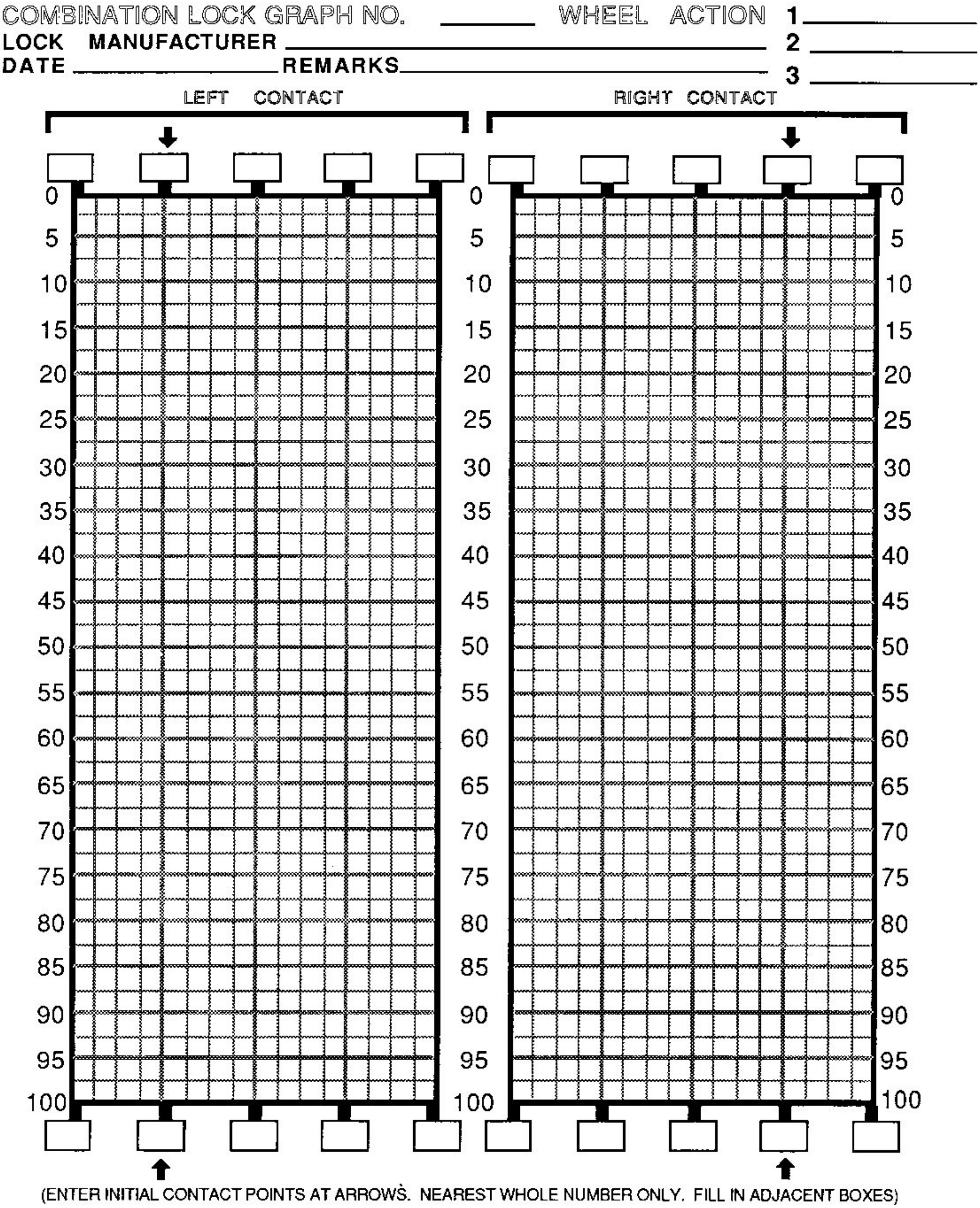


Fig. 2.5

proper method of completing a manipulation graph. Because of the repetitive nature of taking contact readings, it is much easier to record the readings as they are taken, and review or analyze them afterwards. This prevents the necessity of retracing your readings during a manipulation and gives a visual representation of the wheels which is easier to understand. My father once said, "a short pencil is better than a long memory." That was sound advice, and is especially true here. Figure 2.5 above shows a series of dial readings, and a section of a manipulation chart which you will use to plot the contact points. From the blank graph, fig. 2.6, page 26 and the illustration above, you will note that there are actually two sections of the graph. They are the "left contact points" and the "right contact points." The left and right contact points will be plotted from "0" to "100" every two and one half numbers. This will allow the manipulator to graph one full revolution (360°) by taking only 40 readings. You will note that the graph runs from top to bottom from "0" to "100" every 2 1/2 numbers. At the top and bottom of the graphs are a series of boxes. These will be filled out with the "whole number contact points." If you found that the initial contact points of your lock were 9 1/4 and 21 1/8, you would enter "21" in the right contact point box (with the arrow) and "9" in the left contact point box (with the arrow). The other boxes are for the numbers adjacent to the contact point. They will always be in ascending order from left to right. If, as in the above illustration, the left contact point is "9." The other boxes would be properly labeled "8" and "10", "11", "12." Note, in the graph, that the distance between the contact points is divided into quarters. This will allow you to plot quarter numbers on the graph. In figure 2.5, the left contact point for the number "25" is "10." A dot has been entered at the intersection of the line marked "25" (for the number being tested) and the line marked "10" (for the contact



COMBINATION LOCK GRAPH NO. ________ WHEEL ACTION 1 ________

LOCK MANUFACTURER ________ 2 ________

DATE ________ REMARKS ________ 3 ________

(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

LEFT CONTACT
RIGHT CONTACT
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100

Fig. 2.6 Sample Graph Sheet

point). The next number to be tested was "27 1/2." The left contact point was "9 3/4." Following the "9 3/4" line down the graph to the "27 1/2" cross bar, a dot has been entered to indicate the contact reading. The next contact reading taken was with the wheels at "30." The contact reading at "30" was found to be "9 1/2." A dot was entered at "9 1/2," on the "30" cross bar. The left contact point for "32 1/2" has been recorded as "9 1/4" and the left contact point for "35" has been recorded as "9." If a contact point is read as an eighth, simply enter the dot on the correct number line (cross bar) between the appropriate contact point quarter number lines.

Though the contact points and the information they give are the purpose of the graph, you should always fill out the title block at the top of the page. This will allow you to review your progress and test the conclusions you have drawn during the manipulation process. (See fig. 2.6.)

The combination graph number tells the sequence of the graph in a particular manipulation. Graph number one, for example, would be the first graph of the wheel pack. Graph number two would be the second graph of the manipulation, and so on.

Wheel action tells how the wheels were positioned, and what the contact points are testing. (AWL = all wheels left, AWR = all wheels right, 1@ L number / 2&3 AR = wheel one at a known number- wheels 2 and 3 around right, 2 @ R number / 3 @ L number / 1AL = wheels 2 and 3 at known numbers- wheel 1 around right)

Lock manufacturer refers to the lock and not necessarily the manufacturer of the container.

Remarks will be considered after the graph has been run. This area is for any conclusions that you have drawn from the graph. Location of a low spot in the graph will be tested to find which wheel is marking and subsequent graphs will be run using the information obtained.

The date block is for your information and future reference. You may want to include a time of start and finish.

Keep a running record of your progress as a manipulator by filing your old graphs in a ring binder. You may want to look back to a graph of a similar lock at some future time. (i.e., the last Yale four wheel lock I manipulated marked on the 4 wheel first, initial contact point was at 7 1/8, wheel 4 gave only1/8 division indication, manipulation time 4 1/2 hr., etc.)

SUMMARY

In this chapter we have learned the basic principles of the manipulation process. You have found and tested the contact points. You have determined the contact area. You have counted the wheels in the lock by parking at a known number and picking them up one at a time. You have seen one method of determining contact points down to a quarter number. You have seen and understand how to properly enter your contact readings on the combination lock graph. You understand the importance of completely filling out the title block of the lock graph.

STUDY QUESTIONS

The following questions and exercises are to test your understanding of the material covered and reinforce some of the more important points. You must master the material covered in this chapter before you continue.

1. While in the contact area, if the dial is rotated right (clockwise) the left side of the drive cam gate will contact the nose of the lever. This is called the ________ CONTACT POINT. (left or right)

2. What is the contact area?

3. A decrease in the width of the contact area is an indication of what?

4. Describe the proper method of determining the number of wheels in a combination lock.

5. The sides of the drive cam gate are sloped so that the nose of the lever can be ejected from the drive cam by the rotation of the dial. Compare the drive cam gate to a funnel and describe how it is possible that one increment of penetration of the nose of the lever into the drive cam gate will show a larger increment of change in the width of the contact area.

6. Work the exercise on page 24. Does the presence of a gate under the fence always give an indication? Which wheel gave an indication? Place the indicating gate under the fence and determine which wheel indicates next.

7. The combination lock graph is actually two graphs on one sheet. What are the two graphs of ?

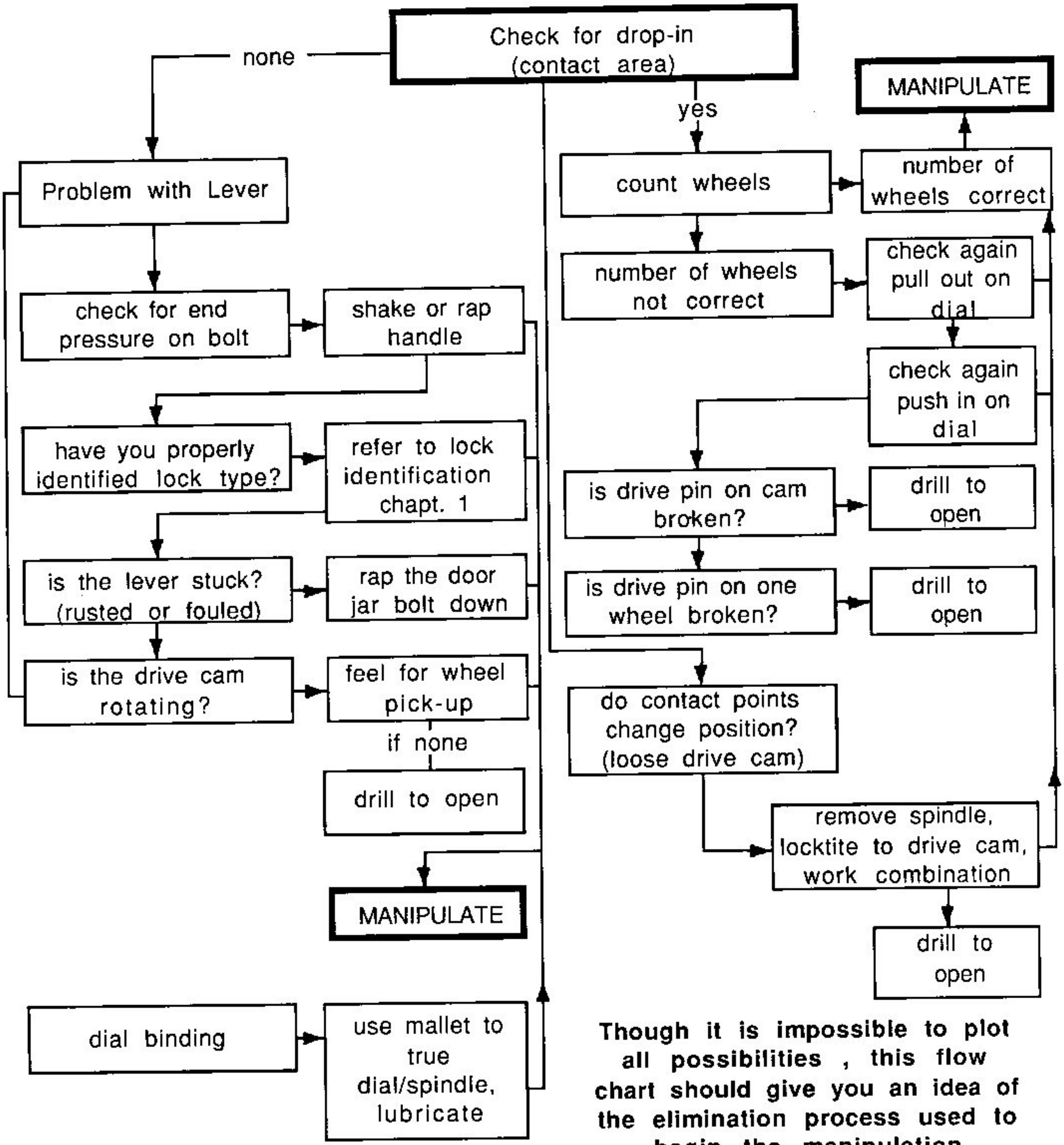
8. The contact point box with the arrow has what special significance.

9. The remarks box of the title block on the combination lock graph should be filled out before the graph is begun. (TRUE/FALSE)

10. Using your cut-away lock, run a short graph of the contact area as the marking (or indicating) wheel gate is moved under the fence. Run the graph from twenty numbers above the actual gate number to twenty numbers below its location. (If the gate is at 35, run your graph from 15 to 55) How wide was the indication of the gate? Did you find that the gate indicated 2 1/2 numbers above and below the actual gate location? Five numbers above and below? Did the left or right contact point give the larger indication?(Or did the left contact point change by 1/4 number while the right contact point stayed constant?)

For study question answers, see page 134.

SERVICE NOTES
FLOW CHART


Check for drop-in (contact area)
none
yes
MANIPULATE
Problem with Lever
count wheels
number of wheels correct
check for end pressure on bolt
shake or rap handle
number of wheels not correct
check again pull out on dial
check again push in on dial
have you properly identified lock type?
refer to lock identification chapt. 1
is drive pin on cam broken?
drill to open
is the lever stuck? (rusted or fouled)
rap the door jar bolt down
is drive pin on one wheel broken?
drill to open
is the drive cam rotating?
feel for wheel pick-up
if none
drill to open
do contact points change position? (loose drive cam)
remove spindle, locktite to drive cam, work combination
MANIPULATE
drill to open
dial binding
use mallet to true dial/spindle, lubricate

Though it is impossible to plot all possibilities , this flow chart should give you an idea of the elimination process used to begin the manipulation.

Chapter Three

Manipulating A Spring Fence Lock

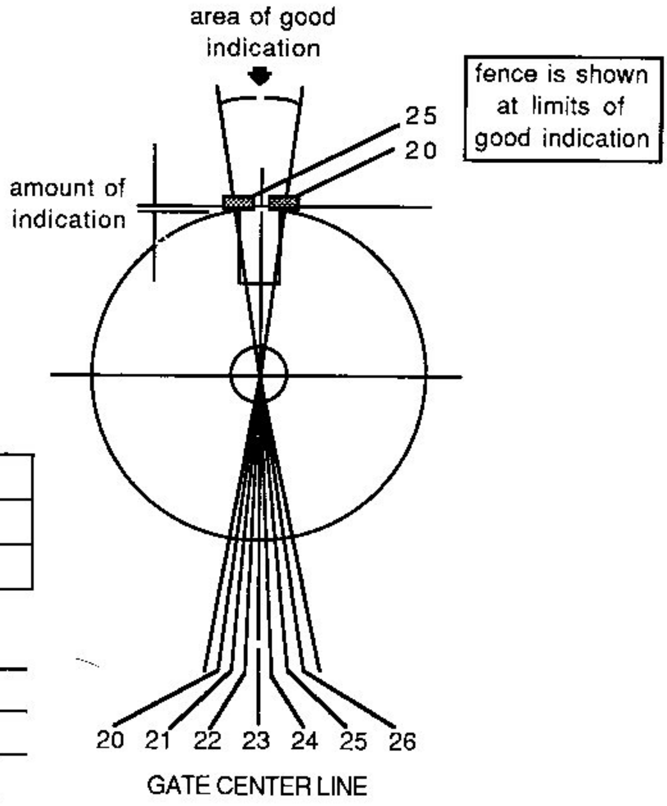
MANIPULATING A SPRING FENCE LOCK

Manipulation principles are introduced with an actual manipulation.

COLLECT DATA

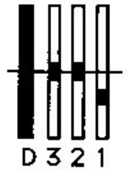
AMPLIFY INDICATIONS

FIND GATE CENTER

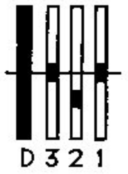

area of good indication
fence is shown at limits of good indication
25
20
amount of indication
20
21
22
23
24
25
26
GATE CENTER LINE

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	▨					
2		▨				
3			▨			

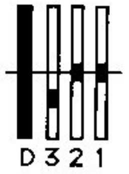
TEST COMBINATIONS



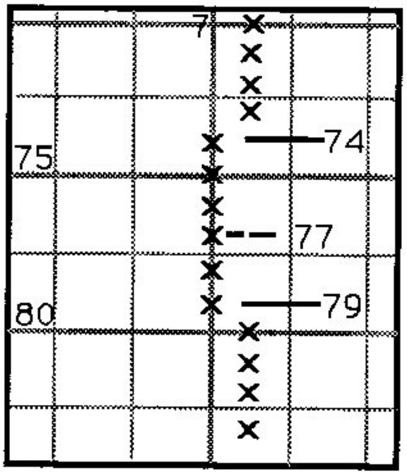
① Turn_____4 times to ______
Turn_____3 times to ______
Turn_____2 times to ______
Turn_____to contact area,
read contact points.



② Turn_____4 times to ______
Turn_____3 times to ______
Turn_____2 times to ______
Turn_____to contact area,
read contact points.



③ Turn_____4 times to ______
Turn_____3 times to ______
Turn_____2 times to ______
Turn_____to contact area,
read contact points.



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Manipulating a Spring Fence Lock

Goals:

1. Upon completion of this chapter, you will have followed an actual manipulation from beginning to end.
2. Upon completion of this chapter, you will understand how to graph the contact points through the contact area without disturbing the position of the wheel pack.
3. Upon completion of this chapter, you will understand how to test an indicating wheel pack and determine which wheel is marking (or indicating), by the use of trial combinations.
4. Upon completion of this chapter, you will understand the logical steps that lead to determining the combination of a standard three wheel safe lock.

INTRODUCTION

After completing the chapter on the principles of manipulation, you have gained a knowledge of the working tools of the professional safe manipulator. This chapter will be your first exposure to the manipulation process in use. The example covered in this chapter is an actual manipulation performed by the author.

****

DETERMINE THE TYPE OF LOCK

The first step in our manipulation will be to determine the type of lock. A simple inspection of the contact area will reveal that there are two contact points. At approximately "89" and "97" you can hear and feel the nose of the lever contacting the left and right slopes of the drive cam gate. The left contact point gives a better click and feels a little harder than the right contact point. This is because the slope of the left side of the drive cam gate is steeper than the right side. The lock has a spring loaded fence. (Refer to chapter one, *identifying the type of fence.*) By identifying the left contact point as the "hard" side, it would be logical to assume that right rotation of the safe dial will retract the bolt. The right contact point will be on a more gradual slope, which makes it a little harder to read but it will give a better indication during the manipulation.

HOW MANY WHEELS?

The second step in our manipulation will be to find the number of wheels in the lock. (Refer to chapter two, *finding the number of wheels in the lock.*) Knowing the contact area to be from "89" to "97" we will rotate the dial right at least five turns (to pick up all wheels) and park the wheel pack at right "50". By rotating the dial left, past "50" we will be able to count the wheels as they are "picked up" by the driver. Repeat this procedure until you are sure of the number of wheels in the lock. We find that our lock has only three wheels.

START GRAPH NUMBER "1"

The third step in the manipulation will be to fill out and begin the first graph. (See fig. 3.1, page 36.) Since this is the first graph of this manipulation, label the graph number "1". The lock is a Diebold (the Diebold cabinet could be using an S&G, Yale OB gravity fence or Diebold lock). Enter the date and time the graph is begun (the time is optional). The last entry is the wheel action. This manipulation was begun with an all wheels right evolution.

After some experience and by studying past manipulations I have adopted an all wheels left evolution when manipulating three wheel spring fence locks. The reason for this is that a larger percentage of the locks indicated on wheel three first, a smaller percentage indicated on wheel one first and wheel two was least likely to give indication on the first graph. If the bolt is retracted with a right rotation of the dial, the last number of the combination (wheel #3) should be a left #. If the first number of the combination (wheel #1) is left, two would be right and three left. By beginning the manipulation with an all wheels left evolution you will not have to work the combination then go back to the drop-in and reverse rotation to retract the bolt. The combination for a three wheel lock that retracts the bolt with a clockwise rotation of the dial is properly set to left-right-left then right to open.

Enter the left and right contact points in the appropriate boxes on the graph (i.e. those marked with the arrows). Fill in the adjacent number boxes from left to right in ascending order.

COLLECT DATA

We begin the graph of the "wheel pack" (all three wheels) by rotating the dial four times right to pick up all three wheels. (*This manipulation was completed before I adopted the all wheels left policy*) The wheel pack is then carried around right to "0". The dial is then rotated counterclockwise to the contact area. Oscillate the dial left and right in the contact area to settle the fence on the wheel pack. Jarring the fence may cause it to fall into a gate if it is resting on the edge of a combination gate. It also helps to get the feel of the contact points.

☞ If the dial has any binding in the contact area caused by a bent dial or dial ring correct it now. It is much easier to manipulate a safe that is free in the contact area than one that is binding up or rubbing where you are trying to take accurate contact readings.

☞ If there is any end play in the spindle shaft, it will effect the accuracy of your contact readings. Some or most of the drive cams ride in a tapered bearing. As the spindle is pushed into the lock it will cause the drive cam to drop down. As the spindle is pulled out (i.e., grasping the dial and pulling it away from the door), the drive cam will be pulled into its bearing and rise to its proper position. If end play is encountered, you must pull out on the dial slightly as you take each contact reading. Failure to do this will cause your contact readings to be erratic and not truly reflect the dimensional accuracy of the wheel pack or wheel you are measuring. Pull out slightly on the dial as you approach the contact point to insure the accuracy of your contact readings.

☞ Address the safe dial squarely. With your line of sight directly in front of the dial, you will eliminate any error caused by viewing the dial off at an angle. Insure that the dial is well lit, without glare or shadows.(See chapter two, *parallax error*.)

100

Begin taking the contact readings by rotating the dial right to pick up all wheels. Continue right to "0" ("100") and park the wheel pack. Rotate the dial left, to the contact area and take your first contact readings. The first contact readings were "89 1/8" and "97 1/8." Record the left contact reading ,"89 1/8," at the bottom of the left column by placing a "dot" at "89 1/8" on the "100" line. Record the right contact point ,"97 1/8," on the right contact point graph by placing a dot in the appropriate spot.

97 1/2

To take the next contact reading (at 97 1/2), rotate the dial right to "0" ,to again pick up the wheel pack, then move the wheel pack 2 1/2 numbers right to 97 1/2. Rotate the dial left to the contact area and carefully take and record your contact point readings. Exercise care in taking the right contact reading, as the fly of the number three wheel will have to be moved to find the actual contact point. If you move the fly too far, you will throw off the number three wheels' position. Taking the contact readings through the contact area can be a little tricky because the flys must be moved far enough to take the contact readings but not so far as to move the combination wheels. If you touch or move the number three wheel slightly, it will have no drastic effect on your graph. The number three wheel can not contain a number in the contact area unless the combination is set to open on two numbers and the drop, but remember we are graphing all three wheels in this graph. If when taking the left contact point you should move the wheel pack, this will definitely effect your graph. The number one and two wheels can contain numbers which may fall in the contact area.

95

To take the next contact reading, rotate the dial right to "97 1/2" to pick up the wheel pack, then move the wheel pack right 2 1/2 numbers to "95." This places the wheel pack inside the contact area. To take the right contact reading, simply move the dial left two numbers to the contact point. Take and record your reading. To take the left contact reading, rotate the dial left to the contact area, but do not touch or pass "95." With the left contact point at 89 1/8, it shouldn't be too hard to take the contact reading without moving the number three wheel. Take and record the left contact point on the appropriate graph.

92 1/2

To take the next contact reading at "92 1/2," rotate the dial right to "95" to pick up the wheel pack, then move the wheel pack 2 1/2 numbers right to "92 1/2." Take and record the contact readings for "92 1/2" using the same procedure as you did for "95."

90

To take the next contact reading, at "90," rotate the dial right to "92 1/2" to pick up the wheel pack, then right 2 1/2 numbers to "90." Rotate the dial left to 97 to take the right contact reading. A right contact reading of "98" is noted. If the contact reading is off the graph, so note by placing an "X" on the border of the graph at the appropriate number as shown. (See fig. 3.1.) To measure the left contact point, rotate the dial left around to "89." Move the fly of the number three wheel to "90." You may touch and move the fly of the number three wheel to 90, but if you pass 90 with the dial, you will move the number three combination wheel out of position. Take and record the left contact reading on the appropriate graph.

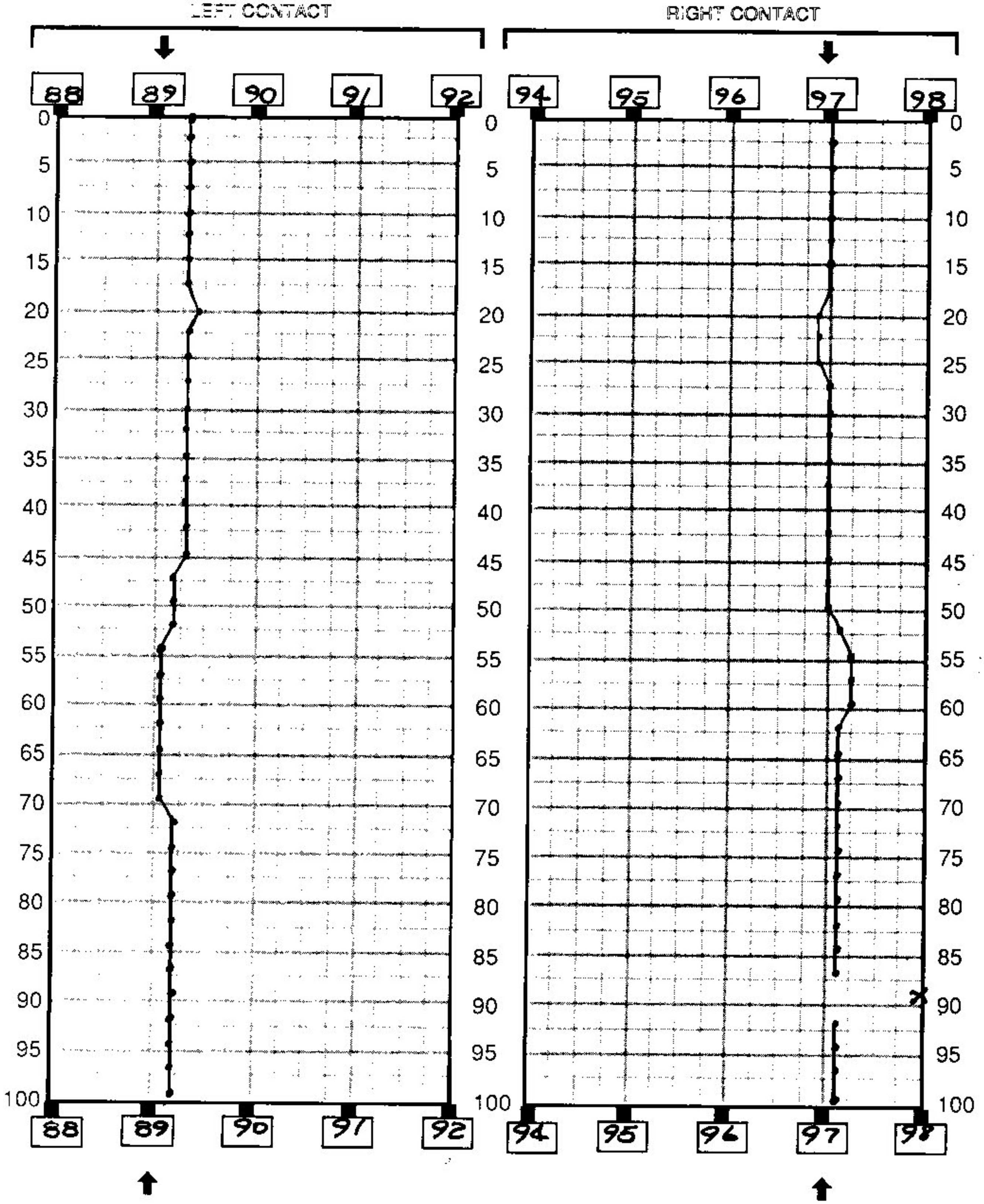
87 1/2

To take the next contact reading, rotate the dial right to "90," to pick up the wheel pack, then right 2 1/2 numbers to "87 1/2." Rotate the dial left to the contact area. Take and record the left and right contact points on the appropriate graphs.

85 - 0

To take the next and all remaining readings on this graph, repeat the procedure as in 871/2 simply moving the wheel pack in 2 1/2 number steps around right until you reach "0."

COMBINATION LOCK GRAPH NO. 1 WHEEL ACTION AWR
LOCK MANUFACTURER DIEBOLD REMARKS
DATE 12-21-81



(Enter initial contact points at arrows. Nearest whole number only.Fill in adjacent number boxes.)

FIG. 3.1 GRAPH #1 "ALL WHEELS RIGHT"

Carefully record your readings on the appropriate left and right contact graphs as they are taken. **Take your time**, go for accuracy not speed.

****

After completing the graphs you will have an accurate representation of the outside dimension of the wheel pack from zero to ninety nine, every two and one half numbers. Most all current production combination locks will give indication using this 2 1/2 number graphing procedure.

ANALYZE YOUR DATA

Now that we have taken our contact readings around the dial, it will be necessary to analyze our data and draw some conclusions which will allow us to progress with the manipulation. By connecting the dots on our graph using a straight edge, we can more clearly see that the wheel pack is giving indication of high and low spots.

Remember that as the nose of the lever enters the drive cam gate, the contact area is reduced. If the fence is allowed to enter the wheel pack by a few thousandths (caused by the presence of a gate or low spot in the wheel pack), it will be reflected by the contact points moving closer together. A high area of the wheel pack will be indicated by the contact points moving farther apart.

Consider the contact area for the wheel pack at "55." The right contact point is "97 1/4." The left contact point is at "89." The contact area is: "97 1/4" minus "89" or 8 1/4. To find the contact area, subtract the left contact point from the right contact point. The difference will be the contact area. The contact area for the wheel pack at "20" is 7 3/4.

96 7/8 - 89 1/8 = 7 3/4

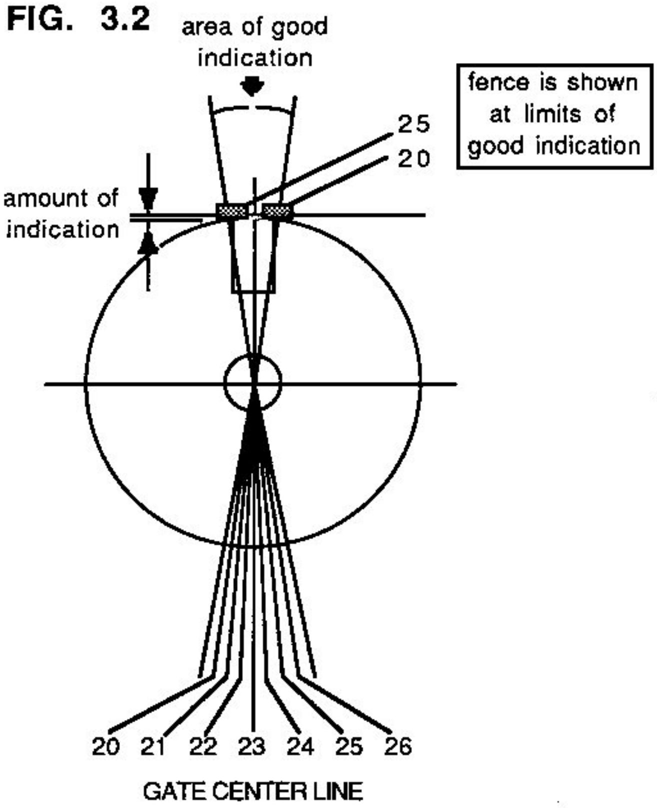
(for a 100 number dial, if the right contact point is smaller than the left contact point, add 100 to the right contact point before subtracting)

The "best" indication of our wheel pack is at "20."

AMPLIFY YOUR INDICATIONS

To further amplify our indications and get a better picture of the suspected gate, it will be necessary to plot the contact points number by number above and below our best indication. Start six or seven numbers above the best

FIG. 3.2



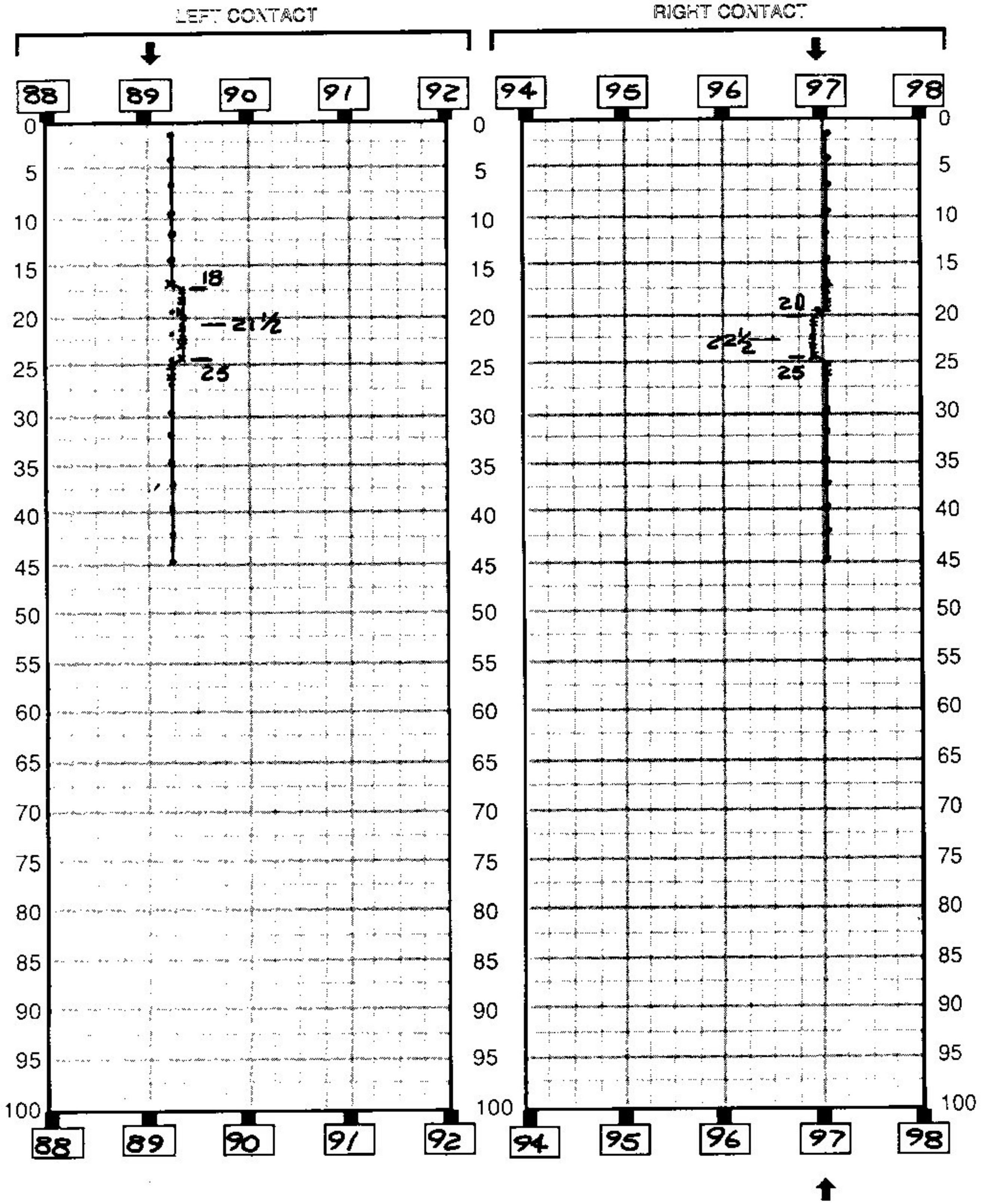
Regardless of the width of the combination gate, it must necessarily leave a flat on the wheel which can be detected by the fence. Even though the fence is not perfectly aligned to enter the gate.

The amount of indication is the measured penetration of the fence into the wheel pack

COMBINATION LOCK GRAPH NO. 1 WHEEL ACTION AWR

LOCK MANUFACTURER DIEBOLD REMARKS CONCLUDE R-22 IS A GATE

DATE 12-21-81 R-22 ON WHEEL 3



(Enter initial contact points at arrows. Nearest whole number only. Fill in adjacent number boxes.)

FIG. 3.3 Illustration #2 of Graph #1 showing graph of each number through the area of best indication to find GATE CENTER.

indication and plot the contact points for each number through the suspected gate area. Use an "X" to record your readings.

In the second illustration of graph number one, the contact points for numbers above and below the best indication have been plotted using an "X" to indicate the contact points. (See fig. 3.3, page 38.) As you can see, the low spot in the wheel pack more clearly resembles a gate.

FIND GATE CENTER

The next step in our manipulation will be to determine the "GATE CENTER" of our indications. The left contact point gives a good indication from "18" to "25" on the dial. The center of this good indication is at "21 1/2." (The good indication is 7 numbers wide, half of 7 is 3 1/2, 18 plus 3 1/2 is "21 1/2.") The right contact points give good indication from "20" to "25." (See fig. 3.2.) The center of this good indication is at "22 1/2." By knowing the center of our left and right good indications, we can find the GATE CENTER of the gate indication by the same method we used to find the center of our good indication above. (The centers are 1 number apart, half of one is one half, 21 1/2 plus 1/2 is "22.") GATE CENTER for this indication of the wheel pack is "22 ." It is safe to conclude that a gate is present under the fence, when the wheel pack is positioned at all wheels right to "22." Enter the conclusion that right-22 is a gate.

WHICH WHEEL IS INDICATING?

The next important step is to determine which combination wheel is giving the indication of a gate. Trial combinations that selectively throw each wheel away from our GATE CENTER number will reveal which wheel is giving our best indication. Begin by setting up a table that will contain your test combinations. In figure3.4, you will see that it is necessary to work three different combinations. Each combination will throw one of the three wheels ten numbers away from our GATE CENTER number.

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	32	22	22	89 3/8	96 7/8	7 1/2
2	22	32	22	89 1/4	96 7/8	7 5/8
3	22	22	32	89 1/4	97	7 3/4

TEST COMBINATIONS

① Turn LEFT 4 times to 32
Turn RIGHT 3 times to 22
Turn LEFT to contact area,
read contact points.

② Turn RIGHT 4 times to 22
Turn LEFT 3 times to 32
Turn RIGHT 2 times to 22
Turn LEFT to contact area,
read contact points.

③ Turn RIGHT 4 times to 22
Turn LEFT 2 times to 32
Turn RIGHT to contact area,
read contact points.

FIG. 3.4

☞ Note that our GATE CENTER number has a direction, "RIGHT 22." The lock that we are manipulating has moveable flys, and will most probably position wheel #1 at or near the same position whether approached from the left or the right. This is not positive and should not be assumed. It has been my experience that wheel one may be as much as two numbers out of position if approached from the opposite side. Wear in the drive pins and flys will cause the last wheel to "lag" or fall behind the dial indication. This wear most often occurs between the drive cam and the number three wheels' fly. It is caused by spinning the dial, which will peen the drive pin out of shape.

When manipulating a lock that does not have moveable drive pins (flys) you will use the same technique. A screw change or pin change type lock will definitely position the combination wheels at different positions when the directions of rotation are reversed. A small point in this manipulation, but deserving of your consideration should the next lock you are called on to service be one of the above mentioned types.

*

Take a moment to study the table of test combinations, figures 3.4 and 3.5.

In test combination number "1," wheel number one is being tested for the presence of the gate. Wheel number one will be positioned ten numbers away from the gate center. Wheels two and three will be positioned at"22," gate center. By recording the contact points, the contact area can be found and recorded.

In test combination number "2," wheel number two is being tested for the presence of the gate. Wheel number two will be positioned ten numbers away from the gate center while wheels one and three are positioned at gate center. Again the contact points will be taken and recorded so the contact area may be determined.

In test combination number "3," wheel number three is being tested for the presence of the gate. Wheel number three will be positioned ten numbers away from the gate center. Wheels one and two will be positioned at the gate center. Record the contact points and find the contact area. The wheel showing the greatest increase in the contact area should be our indicating wheel.

By using this method, it is possible to test the wheels individually. (i.e., without disturbing the position of the other wheels) Wheels two and three are held at a position of known good indication while wheel one is tested. Wheels one and three are held at a position of known good indication while wheel two is tested. Wheels one and two are held while three is tested. Using this method, only one wheel is tested at a time. This is not the only method of determining which wheel is giving indication but it is the most reliable.

You will notice that we chose a number

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	12	22	22	89 1/2	97	7 1/2
2	22	12	22	89 1/2	97	7 1/2
3	22	22	12	89 1/4	97	7 3/4

TEST COMBINATIONS

① Turn LEFT 4 times to 12
Turn RIGHT 3 times to 22
Turn LEFT to contact area,
read contact points.

② Turn RIGHT 4 times to 22
Turn LEFT 3 times to 12
Turn RIGHT 2 times to 22
Turn LEFT to contact area,
read contact points.

③ Turn RIGHT 4 times to 22
Turn LEFT 2 times to 12
Turn RIGHT to contact area,
read contact points.

FIG. 3.5

higher than the gate center for our first set of test combinations. For the known gate center of "22," we chose a "**high test number**" of "32." (See fig. 3.4.) Though this test is very good, it is not always conclusive. It is good practice to also run a low test, as the possibility exists that a second wheel gate may appear at or close to the high test number. Always do a second set of test combinations using a "**low test number.**" (See fig 3.5.)

The "low test number" we have used in the example is "12." (for the test numbers, always use a number 10 numbers above and below the gate center) The test combinations were run for the "low test number" using the same procedure as the high test number.

****

Exercise great care in dialing the test combinations and taking the contact readings. This is the most important step of the manipulation. A mistake at this point will make any further effort fruitless.

****

Once the contact points have been taken and the contact areas determined, all that remains is to analyze your findings. Using the contact area as an indicator, determine which wheel shows the widest contact area.

In the high test table, wheel three tested with the widest contact area. In the low test table, wheel three again showed the widest contact area. It is safe to assume that wheel number three is positioned at "RIGHT 22." The high test table showed wheel three to be the marking wheel. The low test table checked our conclusion and confirmed that wheel three was giving the best indication. On graph number one, figure 3.1, enter "right 22 on wheel #3" in the remarks section. The third number of the combination will be right 22.

REVIEW YOUR PROGRESS

Take a moment to review and consider what steps we have followed to determine the first number of the combination.

1. Determine the type of fence.
2. Locate and define the contact area.
3. Find the number of wheels.
4. Fill out and begin first graph.
5. Collect data. Take contact readings around the dial.
6. Analyze data. Determine area of best indication.
7. Amplify indications. Take contact readings above and below area of best indication.
8. Find "GATE CENTER."
9. Determine which wheel is indicating, using high and low test combinations.

The next step in our first manipulation will be to begin graph number "2." (See fig. 3.6, page 43.) In the second graph we will hold wheel number three at its "known number," and move wheels one and two around left. We have determined that the gate of the number three wheel is at R-22. Using the known gate as a window, we will graph the remaining two wheels to find another gate. Each time wheels one and two are positioned, wheel three will be returned to its known gate before the contact readings are taken. The fence will enter the gate of the number three wheel and be allowed to rest on the remaining two combination wheels. Count your turns carefully during this second graph, it is very important that the wheels be positioned properly. When wheel three is returned to its known gate, wheel two must not be disturbed.

START GRAPH NUMBER "2"

Begin graph number "2," figure 3.6, by filling in the blanks of a new graph sheet. This is the second graph of the lock. The lock is a Diebold. The date and time should be entered as appropriate. Since we have determined that wheel three is set to right 22, the wheel action will be "1&2 AL, 3 @ R-22" (i.e. wheels 1 & 2 around left, wheel 3 at right "22".) Leave the remarks blank open for conclusions to be drawn from information gathered in this graph.

COLLECT DATA

0

Begin the graph at "0" by rotating the dial left four times to "0." Rotate the dial right, from zero, around to zero again. At this point you will pick up the number three wheel. Carry the number three wheel around right to "22." Rotate the dial left to the contact area, take and record the first contact readings.

2 1/2

To take the second contact reading, rotate the dial left to "22." At 22 you will pick up wheel number three only. Continue left, carrying the number three wheel around left to "0." At "0" you will pick up wheels two and one, which were parked there before wheel three was positioned at R-22 in the last step. Continue around left only 2 1/2 numbers to "2 1/2" and stop. (This eliminates unnecessary turning of the dial.) All three wheels are now at left "2 1/2." Rotate the dial right ,around, to 2 1/2 where you will pick up wheel number three. Continue right to position wheel number three at "22." Rotate the dial left to the contact area, take and record the contact readings.

5

To take the next contact reading, rotate the dial left from the contact area around to 22. At 22 you will pick up wheel number three. Continue left to "2 1/2," where wheels two and one were left for the last contact reading. Continue left 2 1/2 numbers to position the wheel pack at "5." Rotate the dial right, around, to "5" to pick up wheel number three. Continue right to again place wheel three at the known gate (22). Rotate the dial left to the contact area. Take and record the contact readings.

7 1/2 - 97 1/2

To take the next and all remaining contact readings, use the same procedure as in "5" above.

☞ Remember that it is not necessary to move wheels two and one more than 2 1/2 numbers at a time. Save time by eliminating unnecessary dial rotation.

☞ Use care in positioning wheel three at the known gate each time. Take your time. Accuracy, not speed, will give you success.

ANALYZE YOUR DATA

Now that we have taken contact readings of wheels two and one every two an one half numbers around the dial, we have developed a representation of their outside dimension. By

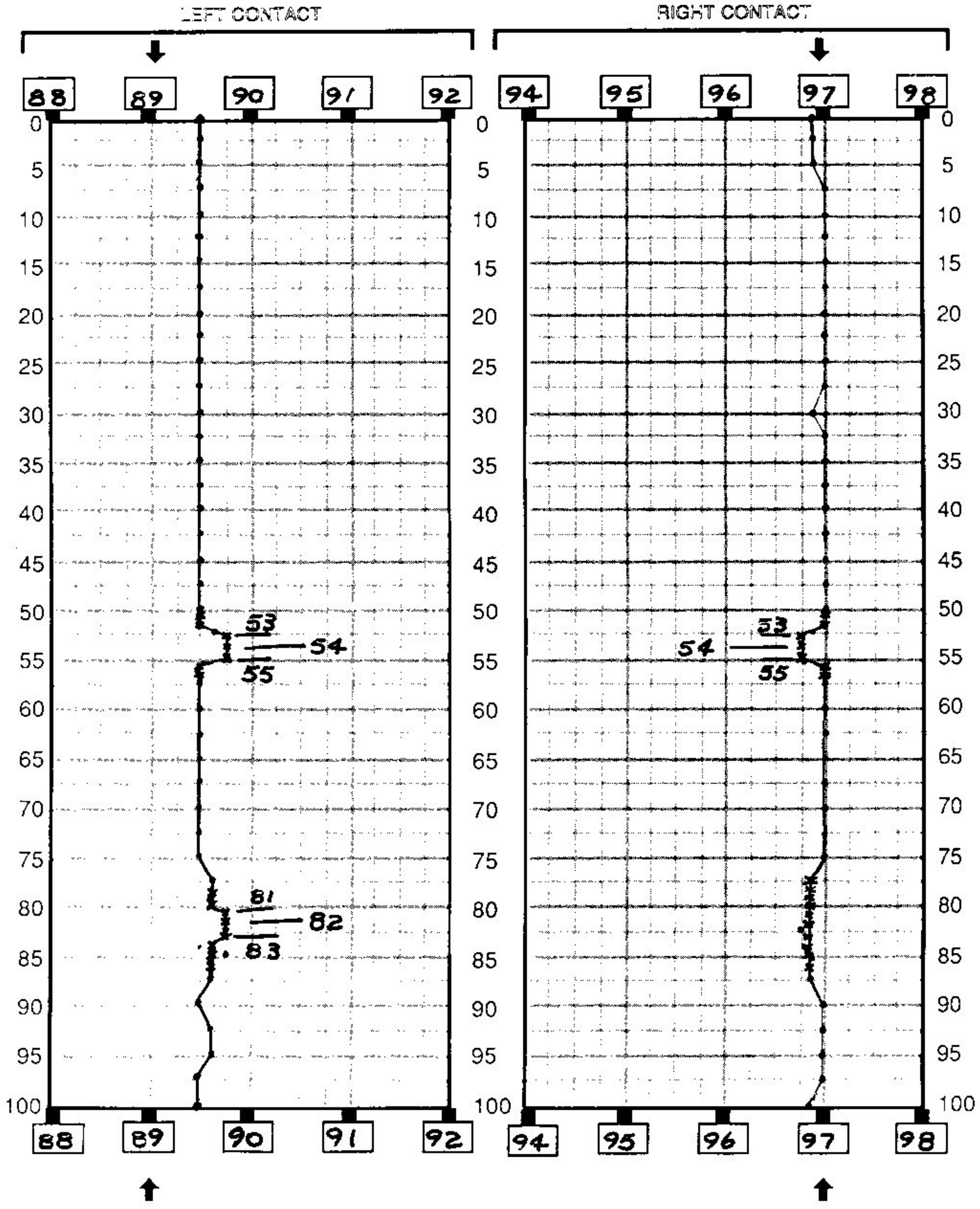
COMBINATION LOCK GRAPH NO. 2 WHEEL ACTION 1&2 AL, 3 @ R-22

LOCK MANUFACTURER DIEBOLD

REMARKS CONCLUDE L-54 IS A GATE

L-54 ON WHEEL 2

DATE 12-21-81



(Enter initial contact points at arrows. Nearest whole number only. Fill in adjacent number boxes.)

FIG. 3.6 GRAPH # 2

using the known gate as a window on the remaining wheels, we were allowed to measure them without interference.

Using a straight edge to connect the dots, we can more clearly see that wheels two and one are showing two areas of good indication. The contact areas between "53" and "55" and between "77" and "87" are indicating low spots in the wheels. Again, remember that a low spot does not necessarily indicate the presence of a gate under the fence. We must make a further inspection of the indications and determine which of the indications is a gate.

AMPLIFY YOUR INDICATIONS

To further amplify our indications and get a better picture of the suspected gate areas, it will again be necessary to plot the contact points number by number above and below the areas of good indication. Plot the contact points far enough above and below the best indications to define their limits. You should be able to see how wide the wheels are indicating.

The indications from "50" to "57" are fairly well defined, showing a good indication about two and one half numbers wide.

The indications from "77" to "87" are wide in the right contact points. The left contact points seem to suggest the presence of a gate, but the graph shows the best indication to be at "53-55."

1. The indication shows the narrowest contact area on the graph.
2. The indication is well defined and resembles a gate.
3. The "rate of change" of the contact readings is greatest at this point.

(The contact readings jump a full quarter number in one number of wheel movement.)

FIND GATE CENTER

We must now find the gate center of the indications. The left contact points are giving good indication from "53" to "55." The center of our good indication is at "54." (55 minus 53 is 2, half of 2 is one, 53 plus 1 is "54.") The right contact points are giving good indication from "53" to "55." The center of this good indication is "54." (55 minus 53 is 2, half of 2 is 1, 53 plus 1 is "54.") The centers of the left and right good indications are both "54." (The centers of good indication are not usually at the same number.) If the centers of good indication were different, we would use the same procedure as above to find the "GATE CENTER." The gate center for our indication is "LEFT-54." Enter this conclusion on graph #2 in the remarks box.

WHICH WHEEL IS INDICATING?

The next important step is to determine which combination wheel is giving the indication of a gate. Trial combinations that selectively throw wheels two and one away from the "GATE CENTER" will reveal the indicating wheel. Begin by setting up a table of test combinations that will contain:

1. The known gate in wheel 3 , as determined by graph number one.
2. The known GATE CENTER
3. A test number ten numbers away from the GATE CENTER

(See fig. 3.7.)

Because we have determined that right 22 is the known gate on wheel number three, enter "22" in the table under "WHEEL #3 AT." Enter "right" and "22" in the test combination blanks that indicate the positioning of wheel number three. (The last wheel to be positioned

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	64	54	22	89 3/4	96 3/4	7
2	54	64	22	89 1\2	97	7 1/2
3			22			

TEST COMBINATIONS

① Turn *right* 4 times to *64*
Turn *left* 3 times to *54*
Turn *right* 2 times to *22*
Turn *left* to contact area,
read contact points.

② Turn *right* 4 times to *54*
Turn *left* 3 times to *64*
Turn *right* 2 times to *22*
Turn *left* to contact area,
read contact points.

~~③ Turn *right* 4 times to ______~~
~~Turn *left* 3 times to ______~~
~~Turn *right* 2 times to *22*~~
~~Turn *left* to contact area,~~
~~read contact points.~~

FIG. 3.7

before reading the contact points.)

For our first set of test combinations, we have chosen a "high" test number. Since the gate center was found to be at "54," the high test number will be "64." Enter "64" in the highlighted blocks of the test table. (See fig. 3.7.) Enter the "GATE CENTER" number, "54," in the remaining blocks of the test table.

Because the number three wheels' gate is known to be at right 22, it will be unnecessary to test wheel number three. You may line out the blocks of the test table that describe the wheel positions and contact information for wheel three. You may also cross out test combination number three, which would be used to test wheel three. They are not used in this illustration.

If we had determined the known gate to be on wheel number one, we would line out the blocks of the test table that describe the wheel positions for testing wheel number one, and cross out test combination number one which tests wheel one. Because wheel number one would be a "KNOWN" it would not be tested.

NOTE:

Because we have determined that this lock has moving drive pins, or flys, we will not give consideration to directional positioning of the combination wheels at this time. For reasons of clarity and to avoid confusion, the next chapter will deal with reversing the direction of a wheel or indication.

By working the test combinations and taking the contact readings, we can determine the contact areas. The contact area which shows deepest penetration of the fence into the wheel pack (or nose of the lever into the drive cam) will indicate the marking wheel. The farther the nose of the lever enters the drive cam, the narrower the contact area will become.

When wheel number one was positioned at "GATE CENTER" and wheel number two was placed at the high test number, the contact area was "7 1/2." Wheel number two was tested and showed a contact area width of "7 1/2."

When wheel number two was positioned at "GATE CENTER" and wheel number one was placed at the high test number, the contact area was "7." Wheel number one was tested and showed a contact area width of "7."

We can look at these indications from either of two ways. (1) When the indicating wheel is positioned at the gate center number the contact area will be narrowest, or (2) when the indicating wheel is positioned at a test number (away from the GATE CENTER number) the indication will be widest.

Our contact area indications show wheel number two to be the indicating wheel. (1) When the GATE CENTER number is placed on wheel two with wheel one positioned away from GATE CENTER, the contact area is narrowest. (2) When wheel number two is positioned at the test number and wheel number one is placed at GATE CENTER, the contact area is widest.

To check our indications and prove our first conclusion that wheel number two is the indicating wheel, a second set of test combinations should be run using a low test number. (See fig. 3.8.)

Set up a second table of test combinations using the same procedure as the first.

1. Enter "22" in blocks under "WHEEL #3 AT"
2. Enter "right-22" in all test combinations in the correct place to position wheel #3 properly
3. Enter the low test number (44 in this example) in the highlighted test blocks
4. Enter the GATE CENTER number (54 in this example) in the remaining blocks
5. Line out the test blocks, and the test combination for the known wheel. (test blocks for wheel #3 and combination #3)

By carefully working the test combinations and taking the contact readings, we will be able to determine the contact areas. The smallest contact area is achieved when wheel number two is positioned at "54," the GATE CENTER. The high and low test tables agree that our suspected gate is at "54" on wheel number two. Enter this conclusion under the remarks heading of graph number two.

wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	44	54	22	89 3/4	96 3/4	7
2	54	44	22	89 1\2	97	7 1/2
3			~~22~~			

TEST COMBINATIONS

① Turn right 4 times to 44
Turn left 3 times to 54
Turn right 2 times to 22
Turn left to contact area,
read contact points.

② Turn right 4 times to 54
Turn left 3 times to 44
Turn right 2 times to 22
Turn left to contact area,
read contact points.

③ ~~Turn right 4 times to ____~~
~~Turn left 3 times to ____~~
~~Turn right 2 times to 22~~
~~Turn left to contact area,~~
~~read contact points.~~

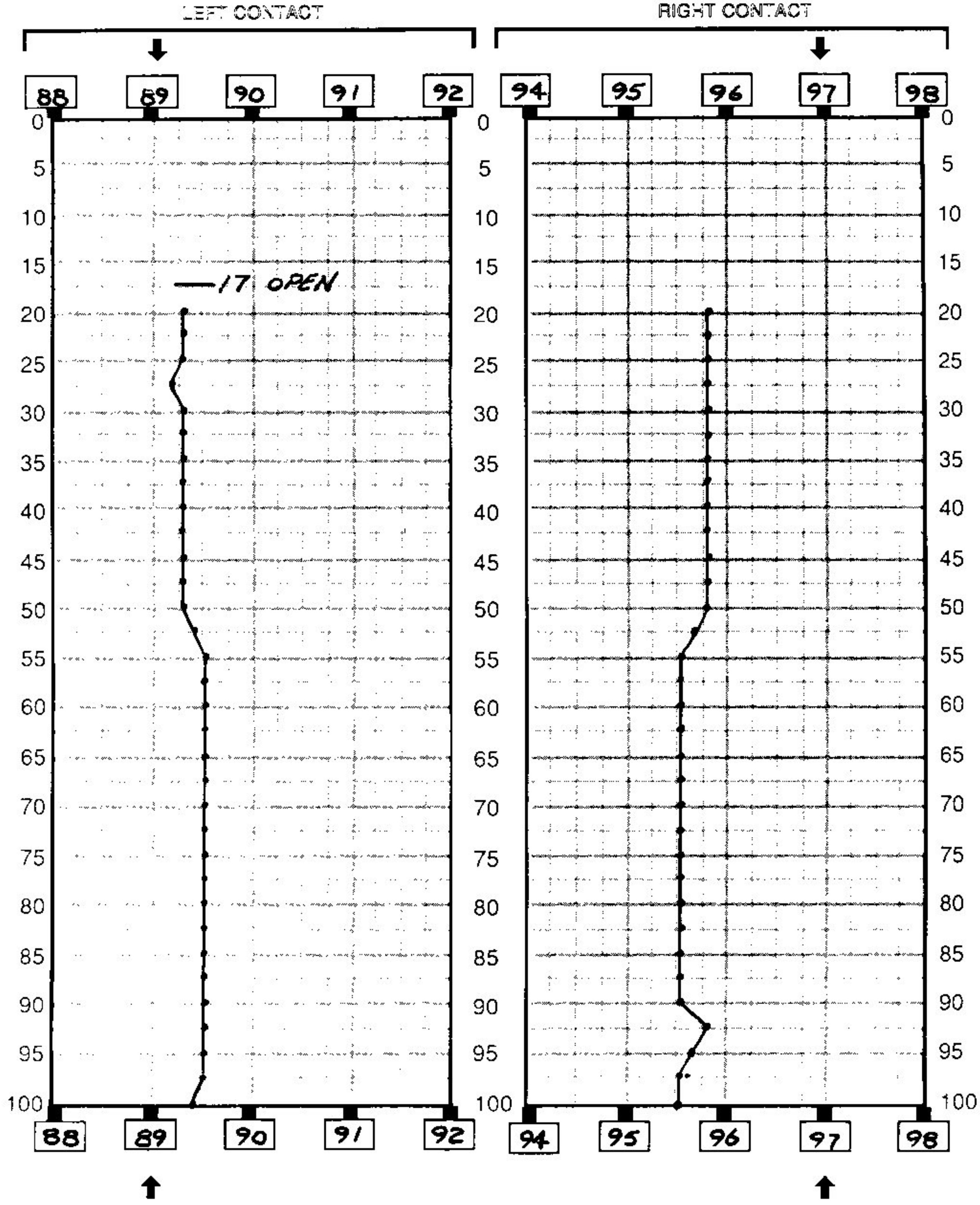
FIG. 3.8

We have now located the combination gates in two of the three wheels of this lock. All that remains is to run a graph of the third wheel and locate the last number. If we have done our work accurately to this point, then this will be the final graph.

START GRAPH NUMBER "3"

Begin graph number three by filling in the blanks of a new graph sheet. (See fig. 3.9) This is the third graph of the lock. The lock is a Diebold. The date and time should be entered as appropriate. Since we have determined that wheel three is set to right "22" and wheel two is set to left "54," the wheel action will be "1 AR, 2@ L-54, 3@ R-22. (i.e. wheel #1 AROUND RIGHT, wheel

COMBINATION LOCK GRAPH NO. 3 WHEEL ACTION 1AR, 2@L-54, 3@R-22
LOCK MANUFACTURER DIEBOLD REMARKS
DATE 12-21-81 R-17 ON WHEEL ONE



(Enter initial contact points at arrows. Nearest whole number only. Fill in adjacent number boxes.)

FIG. 3.9 GRAPH #3

#2 at LEFT "54," wheel #3 at RIGHT "22") Leave the remarks blank open for conclusions to be drawn from information gathered in this graph.

COLLECT DATA

100

Begin the graph at "100" by rotating the dial right four times to "100." Wheel number one is now positioned at right 100. Because we know the gate of wheel number two to be at left "54," rotate the dial left three times to "54," positioning wheel number two at the known gate. The gate of wheel number is at right "22." Rotate the dial right two times to "22." This will position wheel number three at its known gate. Use care in dialing the combinations. Count your turns carefully so as not to throw any of the wheels out of position. Rotate the dial left to the contact area, oscillate the dial to settle the fence on the wheel pack and take the contact readings. Carefully record your readings on the lock graph.

97 1/2

Rotate the dial right four times to the next number. ("97 1/2") You need only move wheel number one 2 1/2 numbers. By counting your turns, you will eliminate unnecessary turning of the dial. Be careful not to short the number of turns, or you will not have repositioned wheel one when you take the contact readings. Rotate the dial left three times to the second number ("54") then right two times to the third number ("22") before returning to the contact area to take the contact readings. Carefully take and record the contact readings for "97 1/2."

95

Rotate the dial right four times to the next number to be tested ("95"). Return wheels two and three to their known gate positions by rotating the dial three times left to "54" then two times right to "22." Return to the contact area to take and record the contact readings.

92 1/2 - 2 1/2

To take the next and all remaining contact readings, use the same procedure as above. Position wheel number one at the test number carefully. Return wheels two and three to their known gate positions every time. Count your turns carefully to avoid placing a wheel at the wrong position.

NOTE:

Use a cut-away lock to help visualize the wheel action. At any time during the manipulation, you should KNOW where you have PLACED each wheel in the lock.

By looking at the graphs and test combination tables, you should know where each wheel was in the lock when the contact readings were taken. It may be easier to think of the wheels position as you PARK them and not so much the number of turns you used to put them there. Review the wheel action. You must KNOW which wheels are being moved and which wheels are not as you turn the dial. Because you cannot see the wheels with your eyes as you move them, you must be able to see them in your mind. Visualize the wheel action as you rotate the dial.

THE SAFE IS OPENED

As you can see, graph number three ends at "17." Seventeen was the last number of the combination. The safe was opened.

Final indications were that the fence entered the wheel pack and allowed the bolt to be withdrawn. This will not always be the case.

WHAT IF ?

In some instances the fence will find the gate in the last wheel by use of the graphing technique, but will not allow the lever to fall far enough to withdraw the bolt. A drastic decrease in the contact area will be noticed when the last gate is located. Oscillate the dial rapidly in the contact area to make the fence move the combination wheels enough to allow it to drop into the gates. Check for end pressure on the lock bolt by shaking the bolt works handle. End pressure on the lock bolt can cause the lever to bind on the lever stop, preventing it from dropping the fence into the wheel gates.

If this does not allow the safe to be opened, graph the last wheel one number at a time from five numbers above the best indication to five numbers below the best indication. (Holding the other wheels at their known gate positions.) This will give you a good indication of the gate location. If the safe does not open, find the GATE CENTER for the last wheel and procede with the next step. Run a short graph for each known number using the same technique as above. Graph each number from five numbers above to five numbers below the known gate number. Hold the wheels not being tested at their same positions. Using your knowledge of wheel action, it is possible to move each wheel independantly of the others. (i.e., Move wheel two, one number at a time, from 49 to 59 while holding wheel one at 17 and returning wheel three to 22 each time.) Change the GATE CENTERS if the indications are different from your original ones.

If you still find that you cannot open the safe, it will be necessary to review the graphs to this point. It is possible that in graph number two, we determined that the gate was at "54" when actually it was at or near 82. Run a short graph, every number, through the area of good indication on the suspect wheel, holding the remaining wheels at their points of best indication.

To obtain useful information from your graphs, move only one wheel at a time. By varying the position of wheel two only or wheel three only, the graph will represent the outline of that wheel alone.

REVIEW YOUR PROGRESS

1

Take a moment to review and consider what steps we have followed to bring us to the conclusion of this manipulation.

1. Determine the type of fence.
2. Locate and define the contact area.
3. Find the number of wheels.
4. Fill out and begin the first graph.
5. Collect data. Take contact readings of the wheel pack around the dial.
6. Analyze data. Determine the area of best indication.
7. Amplify indications. Take contact readings above and below the area of best indication.
8. Find "GATE CENTER."
9. Determine which wheel is indicating, using high and low test combinations.

2

10. Fill out and begin graph number two.
11. Collect data. Take contact readings of wheels two and one, using information gained in the above steps to set wheel three at its known gate.
12. Analyze data. Determine area of best

indication.

13. Amplify indications. Take contact readings above and below area of best indication.
14. Find "GATE CENTER"
15. Determine which wheel is indicating,using high and low test combinations.

3

16. Fill out and begin third graph.
17. Collect data. Using information gained in the first two graphs, take contact readings around the dial on the remaining wheel.

At this point the safe was opened. Had it not opened, the following steps would have been followed.

18. Analyze data. Determine area of best indication.
19. Amplify indication. Take contact readings above and below area of best indication.
20. Find "GATE CENTER"
21. Check "GATE CENTER" for other wheels, one at a time, by graphing contact points (each number) five numbers above and five numbers below the gate center number.
22. Review the graphs. If there are areas of good indication, test them using the gates you are sure of.
    Don't limit your testing to only five numbers above and below.
23. Hold two wheels (those that gave the best indication) and run a graph on the other wheel.
24. If the graph does not show a gate at another position on the wheel, assume that the first indication was correct and graph another wheel.
25. If no results are obtained, after running a graph on each wheel independently, consideration must be given to other means of opening the safe.

It has been my experience, that only about 10% of the safes I am called to open will resist this manipulation technique. I do not include manipulation proof containers in this group.

TRADE SECRETS

Here are ten trade secrets that will almost always insure your success when faced with a lockout problem. These rules can be applied to almost any endeavor. Read them over carefully and treat them as tools of your trade.

1. **Make every move count.** When called to open a safe, take everything you'll need. In most cases, this will include drilling equipment. Go prepared and save a second trip. A professional always has everything he needs.

Take your contact readings carefully and trust your readings. Do it right and you only have to do it once. Don't back track or cover the same readings twice.

Plan your work and work your plan. Follow the method outlined, without skipping steps or taking short cuts. To deviate from the plan is to invite failure.

(*The voice of experience,* I've tried the short cuts, thats why I don't use them)

2. **Use the right tools.** Stay with the basics SIGHT, SOUND AND TOUCH. Don't get sidetracked with a lot of gadgets. Use your basic senses and your knowledge of the lock. Knowledge is what opens safes.

3. **Work from the beginning to the end.**

Follow the steps in order. Follow each step completely and without fail. There are no easy ways, tricks or short cuts to success.

4. **If it works don't mess with it.**

5. **Don't jump to conclusions.** Don't start the trial combinations until you have graphed the whole wheel. Don't guess at the GATE CENTER, work it out one number at a time.

6. **Don't question a conclusion.** If the indications show wheel number two to be the known gate wheel, be positive. Don't change your conclusion unless you can prove something different. Don't make a conclusion until you can prove it.

7. **If what you're doing isn't going to work, change your method of attack** If after the first hour you haven't found any indications (at least two graphs with zero results), drill it. By the same rule, don't give up too easily.

8. **Keep your tools in impeccable shape.** Present yourself as a professional. Keep your pencils sharp and your paperwork neat and clean. A manipulator is not the greasy mechanic that also works on safes. The manipulator is the professional locksmith that opens safes by his superior knowledge of locks and the techniques used to defeat them. This book was written for the professional.

9. **Practice makes perfect.** Learn your trade and practice the art. With time comes confidence and speed. Because your first manipulation will not be perfect or fast, you must be patient and persevere if you want to succeed.

10. **Pay attention.** Concentrate on the job at hand, not the one you have waiting for you. Don't allow yourself to be distracted by conversation or the people around you. Time is money. I manipulate by the job. If it takes fifteen minutes or twelve hours, the price is the same. I prefer to work for fifteen minutes at $700.00 per hour more than working twelve hours at $14.50 per hour.

Do the work, get the money and go home.

STUDY QUESTIONS

The following questions and exercises are to test your understanding of the material covered and reinforce some of the more important points. You must understand and be able to apply the material covered in this chapter before you continue.

1. In the first step of the manipulation, you determined the type of lock and the location of the contact points. During the second step you found that no wheels picked up as the drive cam was rotated. What would be the next step? (hint: don't drill it yet, see to page 29 service notes)

2. You have determined by the handle and dial arrangement or the feel of the contact points that right rotation of the dial will most probably retract the bolt. What should be the wheel action of the first graph? Explain.

3. You discover after inspecting the dial action that the contact points are slightly different if the dial is pulled out or pushed in. The driver has end play that allows you to move it in and out, which changes the lever/drive cam contact. What should you do? Why?

4. The speed with which you can take and record contact readings is a sign of your proficiency. TRUE / FALSE

5. The best indication of the wheel is achieved when the contact area is LARGEST/ SMALLEST.(WIDE/NARROW)

6. What is meant by the term "AMPLIFY YOUR INDICATIONS"? Why is this necessary before you determine the GATE CENTER?

7. Why is it necessary to use the left and right contact points when determining the GATE CENTER? Why not use only the left or right indication?

8. In the trial combination tables, the highlighted blocks are to be filled in with the __________ number.

9. In the test combinations, the combinations are numbered one, two and three. Each is designed to test only one wheel. Which wheel does combination number two test?

10. Explain why it is necessary to run a set of test combinations using a high **and** a low test number.

11. In the text, the "known gate" was compared to a window on the wheel pack. Using this same analogy, explain what the "window" will allow us to see.

12. Why is it necessary to assign a good indication or suspected gate a direction? (i.e., RIGHT-22)

13. Why was it only necessary to work two test combinations after completing graph number two of the manipulation in this chapter?

14. Without the use of a cut-away lock, visualize and follow this wheel action to answer the following questions:

Right four times to "50"
Left two times to "10"

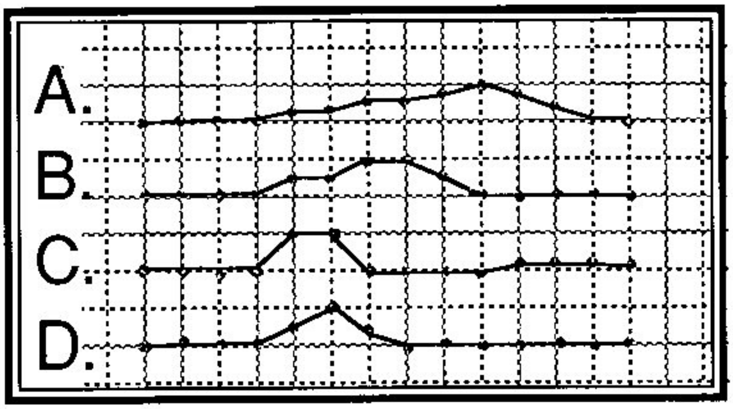
Where is wheel number two positioned?
Where is wheel number three positioned?
Where is wheel number one positioned?

This combination may also be written:

Right four times, stop at "50"
Left, past "50" one time, stop at "10"

15. Is it possible to manipulate all safe locks? YES/NO
(Manipulation proof locks not included.)

16. In the illustration below, which graph shows the greatest "rate of change"?



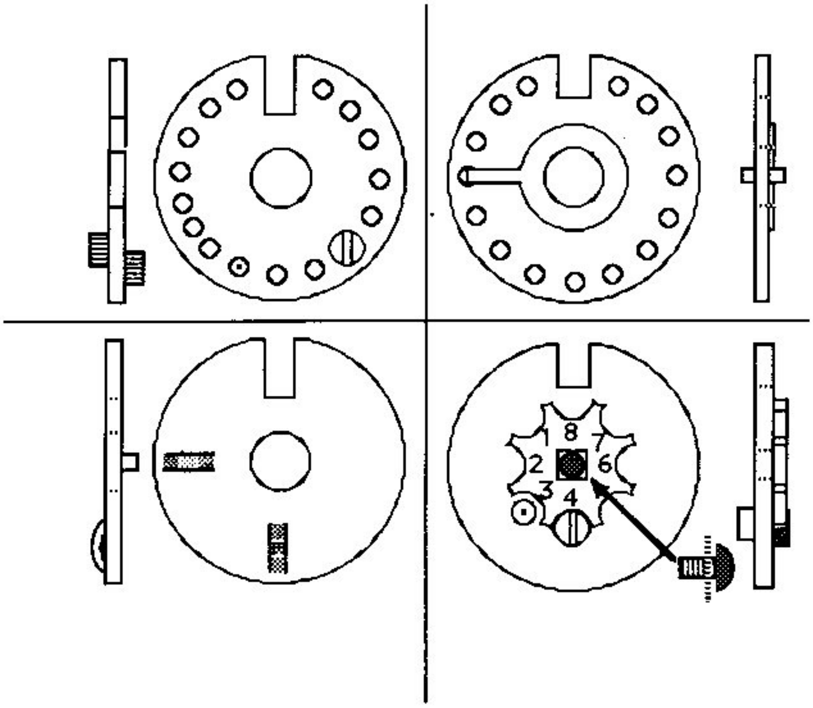
For study question answers, see page 134.

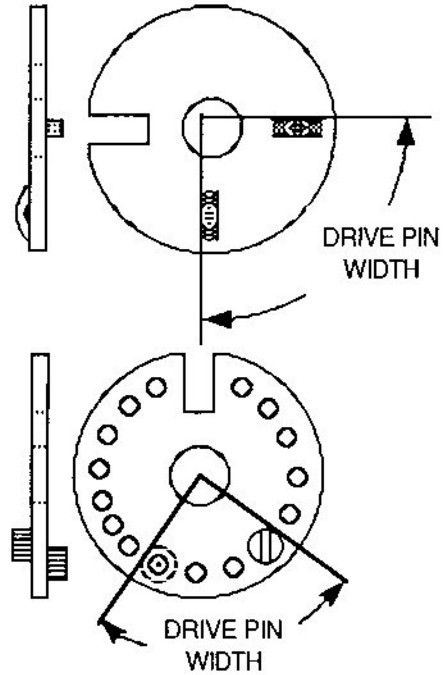
Chapter Four

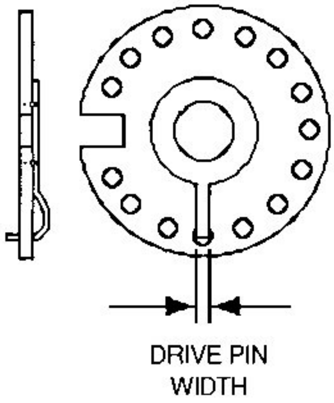
Fixed Drive Pin Locks

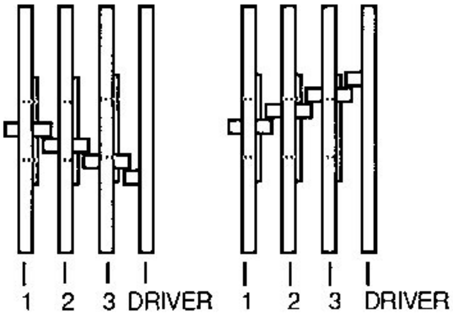
FIXED DRIVE PIN LOCKS

Introduction to fixed drive pins and the special techniques used to manipulate a lock that uses them.




DRIVE PIN WIDTH
DRIVE PIN WIDTH


DRIVE PIN WIDTH


1
2
3
DRIVER
1
2
3
DRIVER

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Fixed drive pin locks

Goals:

1. Upon completion of this chapter, you will be familiar with the fixed drive pin (screw change, pin change, no change and hole change) type lock, and the special techniques used to manipulate them.
2. Upon completion of this chapter you will know why it is necessary to assign a direction to indications obtained when manipulating a fixed drive pin type lock.

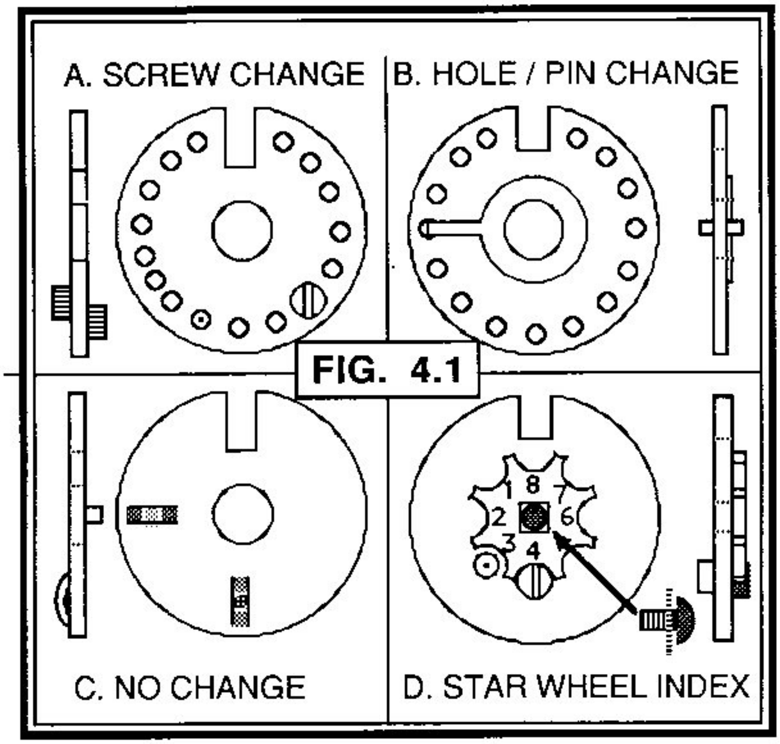


FIG. 4.1

INTRODUCTION

After completing the chapter on manipulating a spring fence type lock, you should have a good working knowledge of the manipulation process. This chapter will deal primarily with the special techniques necessary to successfully manipulate a lock with fixed drive pins. A large percentage of the locks encountered on older and less expensive safes will be of the fixed drive pin type.

****

FIXED DRIVE PINS

The fixed drive pin lock can be configured in many ways. Some of the fixed drive pin locks don't even have the provision for changing the combination. The locks to be found on lower priced fire boxes sold by many discount stores fall into this group.

Don't be misled by the cost of the container when called to open to open it. Even the least expensive safe you can find will give you a considerable amount of difficulty if the proper methods are not used to open it. Manipulation is a profitable method of opening these low end security containers.

Figure 4.1 illustrates four types of fixed drive pin type wheels. Illustration "A" is a **screw change** type wheel. As you can see, it is possible to change the position of the drive pin to fifteen possible locations only. The wheel pictured would be a number two, three or four wheel because it has two drive pins. If this were wheel number one, there would be no need for two drive pins. One drive pin receives positioning information from the driver. The other drive pin, on the reverse side of the wheel, transmits motion to the next adjacent wheel.

Illustration "B" is a **hole change or pin change** type wheel. The wheel pictured has fifteen possible numbers, but it is also common to see wheels with twenty and twenty-five holes. This type wheel either has the holes labeled to show the corresponding combination number for each position, or a peek hole in the lock case to see the gates as they are aligned under the fence. The drive pin extends through the wheel to transmit motion to the next adjacent wheel, eliminating the necessity for two drive pins in the wheel. When changing the combination on locks using this type of wheel, care must be taken to replace the drive pins in the correct wheels as the number one wheel sometimes has a shorter drive pin, there being no need to transmit motion to an adjacent wheel.

Illustration "C" is a new type of wheel that is of the least expensive type. This is the **no change** type wheel. This wheel is made with fixed drive pins that cannot be changed. If you had a combination penny bank as a child, it probably had wheels of this type. The drive pins are formed or punched into the wheels and may be placed at any position around the wheel. Another form of no change type wheel very much resembles the screw change wheel in illustration "A," with the exception that rivets are used in place of screws.

Illustration "D" is a drive cam and not a combination wheel. It is included in this group because it is a fixed drive pin type wheel. This drive cam allows the combination of a no change or screw change type lock to be indexed by the number of notches in the star wheel. Note that the combination is not changed. It is only indexed around the dial by changing the position of the dial with reference to the drive cam and wheel pack. If an old combination is known, the change in the position of the drop-in may reveal the new combination. (If the old combination was 50-25-50 to open, and the new last number or drop-in was found to be at 25, the unknown combination would be 25-0-25.) For a no change lock having a drive cam like the one pictured, there would be eight possible combinations. Each indexed by twelve and one half numbers.The old Victor safes used nine possible positions of the drive cam to give a ten number index of the combination. Some Sentry safes sold today use a similar arrangement with a screw change wheel to achieve a twenty possible combination index (no shift of drop-in). When called to a lockout where the customer has changed the combination on a safe of this type, always ask if there is a record of the old combination.

There are many variations on the fixed drive pin lock, but these will give you a good idea of the arrangement of drive pins that fall into this category.

STACKING

Figure 4.2 shows the effect of stacking.

FIG. 4.2

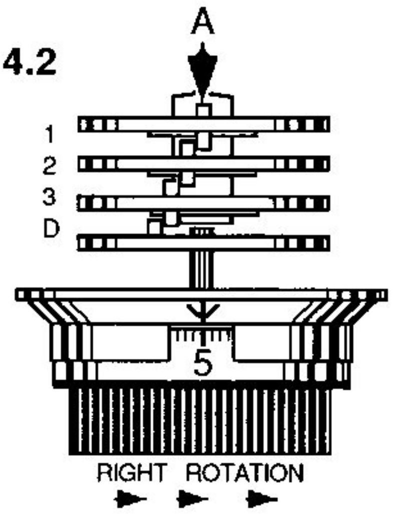
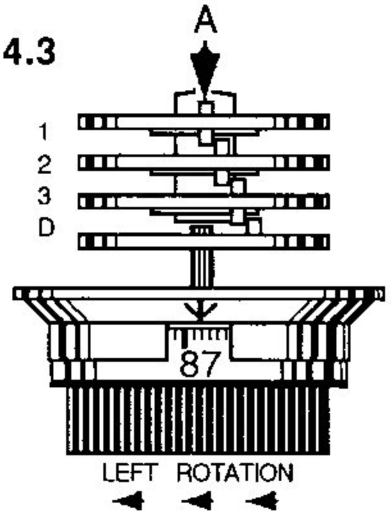


FIG. 4.3



Right rotation of the dial has carried the number one wheel around and placed the drive pin at position "A." Note that the dial reading is "5."

To achieve the same positioning of wheel number one with left rotation of the dial, (fig. 4.3) the dial is at "87." We see an eighteen (18) number spread in the dial reading, with the number one wheel placed at the same position. What we have shown here is the effect the width of the drive pins, in a fixed drive pin lock, have on the positioning of the wheels when the direction of rotation is reversed. To place a given wheel at a desired position, in a fixed drive pin lock, the direction of rotation becomes a major consideration.

(In this example the actual numeric shift of the dial readings, caused by drive pin width and stacking, were measured in a lock using hole change type wheels. Screw change wheels would have caused a greater shift in the readings, because of the increased width of the drive pins.)

PROBLEM

1. How do we know when there is a stacking problem?
2. How do we "prove" the indication of a gate to be on a particular wheel?
3. Where do we look for the displaced or shifted gate? (Rule #1,page 59.)
4. How can we reverse the direction of the indicating wheel to restore the correct dialing sequence? (Rule #2, page 60.)

-1-

Let's, for a moment, consider a manipulation problem that would require the direction of a wheel to be reversed.

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	43	33	47	0	7	7
2	33	43	47	0	7	7
3						

TEST COMBINATIONS

① Turn left 4 times to 43
Turn right 3 times to 33
Turn left 2 times to 47
Turn right to contact area,
read contact points.

② Turn left 4 times to 33
Turn right 3 times to 43
Turn left 2 times to 47
Turn right to contact area,
read contact points.

~~③ Turn left 4 times to ______~~
~~Turn right 3 times to ______~~
~~Turn left 2 times to ______~~
~~Turn right to contact area,~~
~~read contact points.~~

FIG. 4.4

The manipulation is begun and the first wheel to indicate is the number three wheel. The number three wheel is found to be set to "LEFT 47." The next graph was run and a gate was found to be at "RIGHT 33." The contact area was "6," with the contact points at "0" and "6." A test combination table was set up and test combinations were run to selectively throw wheels one and two away from our known GATE CENTER of "right 33."

Study the table of test combinations, figure 4.4, on this page. You will find two faults with our test procedure. First, wheel number one was never placed at **RIGHT** 33. Second, if our known best indication showed a contact area of "6," why was the contact area of "7" the best we could find using the test combinations as shown?

The fact that wheel number one was never placed at"RIGHT 33" is the reason that our best indication (contact area of "6") was not found, using the trial combinations.

-2-

We can prove that wheel number one is the indicating wheel by a special trial combination that will place wheel one at "RIGHT 33 ," wheel number two at a test number (also a right number) and wheel three at its known GATE CENTER.

TEST COMBINATION

1. TURN right FOUR TIMES TO 33
2. TURN left PAST 33 TWO TIMES, STOP AT 43
3. TURN right PAST 43 ONE TIME, STOP AT 43
4. TURN left PAST 43 ONE TIME, STOP AT 47
5. TURN right TO THE CONTACT AREA, READ CONTACT POINTS.

Let's examine the wheel action, to see where the wheels have been placed.

1. Right four times to "33" will place all wheels at "RIGHT 33."
2. Left, past 33 two times will pick up wheels three and two and begin to carry them around left. Stop at 43 to park wheels three and two at "LEFT 43." Wheel number one will not have been moved away from "RIGHT 33."
3. Turn right, past "43" one time to pick up wheel three and carry it around right. At some number right of "43," wheel number two will pick up and be carried right to the high test number, "43."

We have now placed wheel number one at "right 33" and wheel number two at "right 43."

4. Turn left, past "43" one time to pick up wheel number three and carry it left to our known GATE CENTER of "47."

We have now placed wheel number one at "right 33," wheel number two at "right 43" and wheel number three at "left 47."

5. Turn right to the contact area to take and record the contact points. The contact area should be the same or close to the best indication of the graph that indicated that a gate was present at "RIGHT 33."

If, after graphing two adjacent wheels, you work the test combinations and find that the contact area is wider than the contact area achieved in the graph, try this procedure to "prove" the wheel that was not placed properly because of the direction of rotation. (adjacent wheels would be 1&2 or 2&3, not 1&3, as wheels one and three would normally be rotated in the same direction (i.e., **R**-L-**R** or **L**-R-**L**).

If running the special combination sequence restores the gate indication, then it will be necessary to reverse the direction of the indicating wheel to obtain a "LEFT" number that will position the gate of the indicating wheel under the fence. This is really very simple if you remember that the gate always leads the dial in the direction of rotation. If you rotate the dial right, the gate will be pushed ahead of the dial reading by the widths of the drive pins.

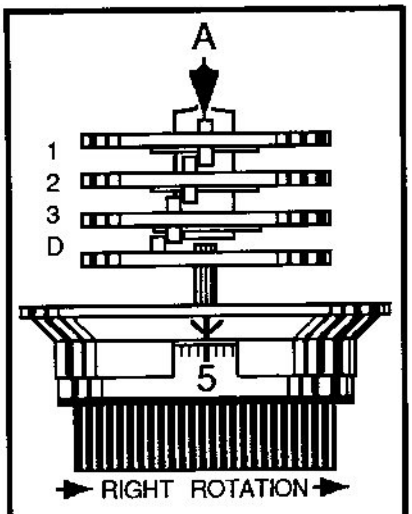


FIG. 4.5

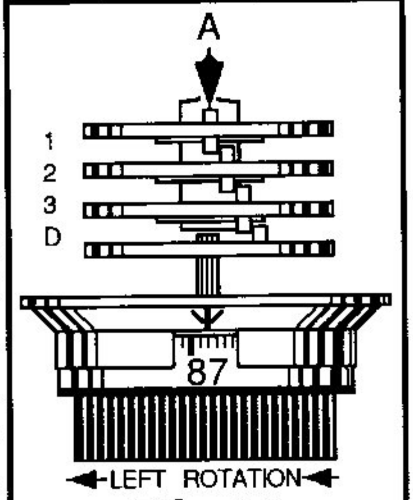


FIG. 4.6

A gate that indicates at "5" with right rotation of the dial (fig. 4.5) will indicate at some number to the left of "5" with left rotation of the dial. In figure 4.6, wheel one is properly positioned when the dial is rotated left to "87"(18 numbers left of "5").

If we were to reverse the above example, we would say, as before, the gate leads the dial by the widths of the drive pins. Assume wheel #1 to be properly positioned with the dial at "LEFT 87." Right rotation of the dial will position the wheel correctly at some number displaced to the right of "87" by the collective widths of the drive pins. In our example, the collective width of the drive pins was 18 numbers on the dial. This displaced the dial 18 numbers to the right, bringing the dial reading to "87 + 18" or "5" ("105").

-3-

RULE #1 FOR REVERSING INDICATION

Where to look for the gate.

A. Reversing a "➡ RIGHT ➡" number to a "⬅ LEFT ⬅" number? The new dial reading will be "⬅ LEFT ⬅" of the original dial reading.

Based on the illustration, right 5 positioned wheel number one at the same point as left 87. On the dial, 87 is left of 5. (See figures 4.5 and 4.6.)

B. Reversing a "⬅ LEFT ⬅" number to a "➡ RIGHT ➡" number? The new dial reading will be "➡ RIGHT ➡" of the original dial reading.

Based on the illustration, left 87 positioned wheel number one at the same point as right 5. On the dial, 5 is right of 87. (See figures 4.5 and 4.6.)

FIG. 4.7

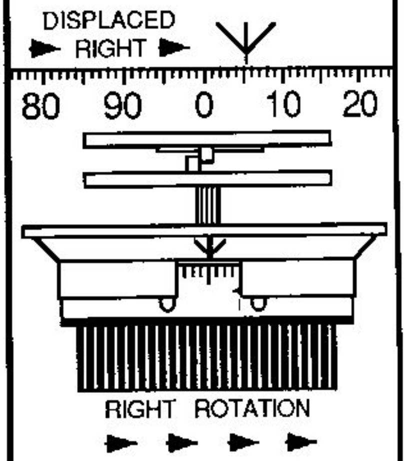
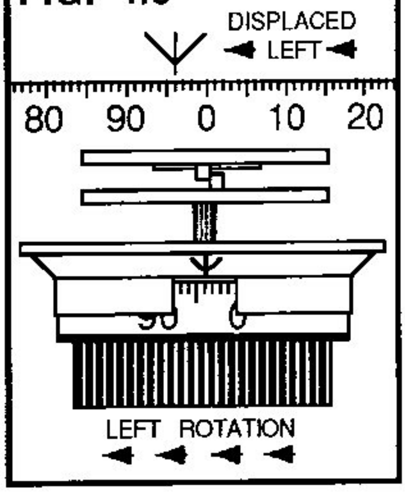


FIG. 4.8



Another way of showing the direction of numeric shift of the dial, if the direction of rotation is reversed, is by freezing a wheel in the lock. Approaching the wheel from the left (right rotation of the dial, figure 4.7) we find that the dial stops at "5" when the drive pins touch. As the dial is rotated left, The drive pin of the driver approaches the frozen wheel from the right. The dial stops at "96" as the drive pins touch. (Left rotation of the dial, fig. 4.8.) The shift in the dial reading measures 9 units on the dial for wheel number three. (If the frozen wheel had a "fly" or moveable drive pin, the dial would have stopped at zero for both left and right rotation of the dial)

With right rotation of the dial, the driver approaches the drive pin from the left and is therefore displaced left. With left rotation of the dial, the driver approaches the drive pin from the right and is therefore displaced right. Knowing where to look for the gate will save you from running a complete graph to find the known gate from the opposite direction.

-4-

RULE #2 FOR REVERSING DIRECTION

A method of finding the gate.

A. Reversing a "➡ RIGHT ➡" number to a "⬅ LEFT ⬅" number? Subtract "25" from the right number and run a short graph of the indicating wheel, moving the wheel left toward the right number.

Based on the example, if the right number was "5," subtract 25 from 5 and begin the graph at "80." The graph would be "wheel#1-AL from "80" to "5," wheel #2 at R-33, wheel #3 at L-47." (See figures 4.5 and 4.6)

B. Reversing a "⬅ LEFT ⬅" number to a "➡ RIGHT ➡" number? Add "25" to the left number and run a short graph of the indicating wheel, moving the wheel right toward the left number.

Based on the example, if the left number was "87," add 25 to 87 and begin the graph at "12." The graph would be "wheel #1-AR from "12" to "87," wheels #2 and #3 at their appropriate positions. (The illustration was set up to require the reversal of a right number to a left number.)

After working through the short graph, the indicating gate will be located at the new number, with the desired direction of rotation.

NOTE:

There will be occasion to use this same procedure when two gates indicate on one graph. Park one wheel at its known GATE CENTER and reverse the second indicating wheels GATE CENTER (adjacent wheel) using RULE #2. A short graph could reveal the gate of the adjacent wheel without the necessity of running a complete graph. Time is money.

NOTE:

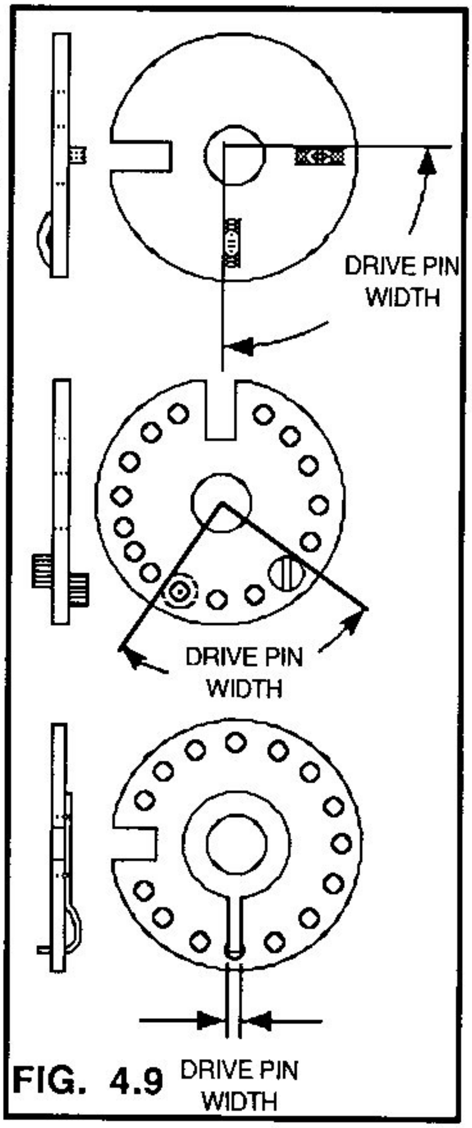


FIG. 4.9

Adding or subtracting "25" from the indicating gate will work 80% of the time. If the drive pins are extraordinarily wide, the indication may be displaced farther than 25 numbers. If the gate is not found in a 25 number graph, you may need to expand the graph. In figure 4.9, you will see that the effective width of a drive pin can be quite wide. Good wheel design would dictate that the drive pins be as narrow as possible, but some wheel designs do not lend themselves well to this line of thought. As the effective width of the drive pins increases, the number of useable combinations decreases. Stacking three wheels with drive pins of this type can displace the gate indication almost anywhere. It may be necessary to expand the graph around the dial, or until the known gate is located in the desired direction. You know where to look. Continue graphing the wheel around in the desired direction until the gate is located.

REVIEW YOUR PROGRESS

Take a moment to review and consider the material covered in this chapter.

1. We found that a lock with fixed drive pins must be treated differently than a lock with moveable drive pins or "flys." Directional positioning of the wheels is a major consideration.
2. We found that "STACKING" of the drive pins caused the wheels within the lock to be placed at entirely different positions for the same dial reading, if left or right rotation of the dial was used.
3. A new trial combination was introduced, that would allow us to place two adjacent wheels at different positions using the same direction of dial rotation.
4. Two rules for reversing the direction of rotation of an indication were introduced. Rule number one told us where to look. Rule number two told us how to find the gate.
5. We found that it was only necessary to run a short graph of the indicating wheel (25 numbers) to reveal the reversed indicating number (in most cases).

STUDY QUESTIONS

The following questions and exercises are to test your understanding of the material covered and reinforce some of the more important points. You must understand and be able to apply the material covered if you want consistent success in your manipulations.

1. Name three types of fixed drive pin type wheels.

Explain the advantages and disadvantages of each.

2. What is meant by the term "indexing the combination"?

3. For "no change" type combination wheels, if the drive cam has twenty positions for its' drive pin, how many different combinations are possible?

What do all these combinations have in common?

4. What effect does the width of the drive pins have on the directional positioning of the combination wheels of a fixed drive pin type lock?

Explain the term "SPREAD" with reference to drive pin width.

5. What is the first indication of a stacking problem in a manipulation?

6. Why is the standard test combination routine not effective when testing the indications of a fixed drive pin type lock?

7. What is the purpose of the special trial combination routine outlined in this chapter? Explain the wheel action of this routine.

8. During the first steps of a manipulation it is necessary to determine the number of wheels in the lock. For this procedure, all wheels were parked at right "50." Left rotation of the dial revealed that wheel number three picked up at 40 or 41, wheel number two picked up at 36 and wheel number one picked up at about 32.

What has the close observation during this first step in the manipulation told us of the lock?

What would a wider spread in the pick up points tell us of the lock?

9. After working through the short graph (25 numbers), we have not found the indicated gate. The contact area has remained relatively constant over the width of our graphing area.

What should be your next step in this manipulation?

10. The gate always __________ the dial reading in the direction of rotation. (leads / lags)

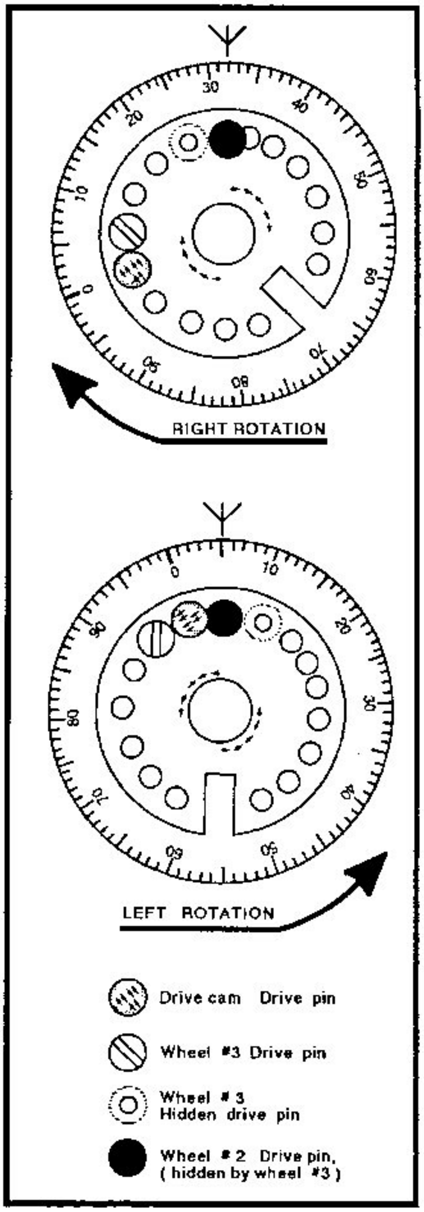
11. Reversing a "➡ RIGHT ➡ " number to a "⬅ LEFT ⬅ " number? _________ "25" from/to the right number and run a short graph of the indicating wheel, moving the wheel left, toward the right number. (ADD or SUBTRACT ?)

Think through this question, don't just look back to the text.

12. When reversing the direction of an indicating gate, the position of the reversed number will always be within 25 numbers of the indicating gate.

TRUE /FALSE

Use the diagram, to answer the following questions.



13. If right rotation of the dial to "32" properly places the gate of wheel #2 under the fence, and left rotation of the dial to "5" places wheel #2 at the same position, what is the "SPREAD" caused by the width of the drive pin of wheel number three?

14. During a manipulation, you have found the gates of wheels #1 and #2. Test combinations have proved their GATE CENTERS to be correct and the contact area is found to be "7" numbers wide. While running the graph:

wheel #1 @ GATE CENTER #1,
wheel #2 @ GATE CENTER #2 (right-32)
3 AROUND LEFT (from 32)

you find that the contact area jumps from "7" to "7 1/2" at "5" on the dial.

A. What could cause the change in the contact area?

B. What would the graph represent from "5" to "32"? (wheel number two or wheel number three?)

C. Did wheel #3 pick up at 32, or some number Left of 32? (20?)

D. "25" is the last number of the combination. How would you find its location?

1. Run a graph around left from "32"

OR

2. Begin the graph left of the last number to compensate for the width of the drive pins?
(20 is left of 32)

For study question answers, see page 135.

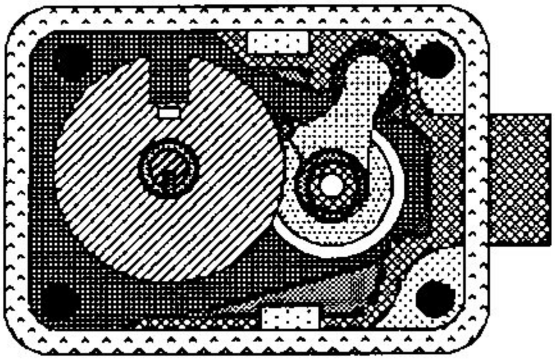
NOTES

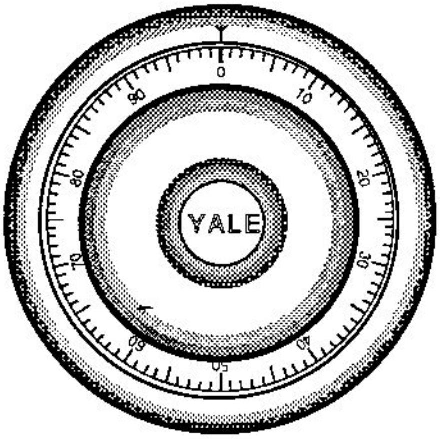
Chapter Five

The Friction Fence Lock

THE FRICTION FENCE LOCK

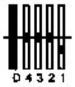
Manipulation techniques introduced.
The four wheel manipulation format is introduced.



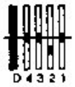


Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	WHEEL #4 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	▨						
2		▨					
3			▨				
4				▨			

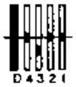
TEST COMBINATIONS



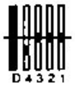
① Turn_____ 5 times to _____
Turn_____ 4 times to _____
Turn_____ 3 times to _____
Turn_____ 2 times to _____
Turn_____ to contact area, read contact points.



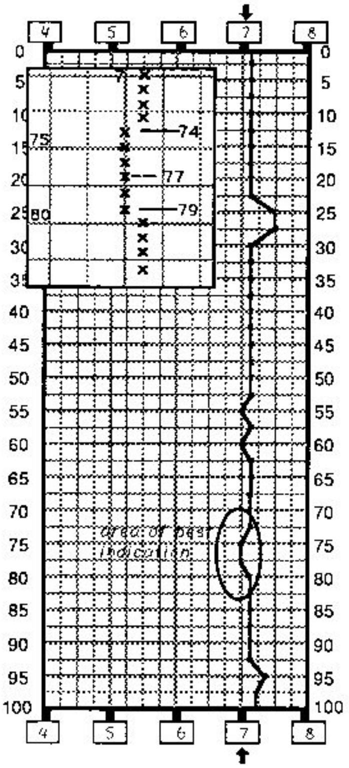
② Turn_____ 5 times to _____
Turn_____ 4 times to _____
Turn_____ 3 times to _____
Turn_____ 2 times to _____
Turn_____ to contact area, read contact points.



③ Turn_____ 5 times to _____
Turn_____ 4 times to _____
Turn_____ 3 times to _____
Turn_____ 2 times to _____
Turn_____ to contact area, read contact points.



④ Turn_____ 5 times to _____
Turn_____ 4 times to _____
Turn_____ 3 times to _____
Turn_____ 2 times to _____
Turn_____ to contact area, read contact points.



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THE FRICTION FENCE

GOALS:

1. Upon completion of this chapter, you will be familiar with the manipulation procedure for the friction fence type lock.
2. Upon completion of this chapter, you will be familiar with the procedure for manipulating a four wheel lock.

INTRODUCTION

As you recall, the friction fence lock has some differences that make it a bit more difficult to manipulate. First and most important is the fact that the lock only gives a contact reading when the dial is rotated left. This lock must be manipulated using a single-graph, in stead of the customary double graph format. Second, this is a fairly well made lock. This means that the wheels are very accurate in their concentricity and dimension. The indications will be small. The Yale friction fence lock is a very formidable lock to manipulate but it is not impossible. It will indicate and can be manipulated using the method outlined here.

****

THE FRICTION FENCE LOCK

The first step in our manipulation will be to determine the type of lock. Inspection of the contact area reveals that there is only a contact point felt when the dial is rotated left. (See fig. 5.1.) No contact point can be felt when the dial is rotated right. The contact point is found to be at "7 1/8." The contact point is fairly distinct and gives a solid reading which is easy to feel and hear.

HOW MANY WHEELS ?

The second step in the manipulation will be to determine the number of wheels in the lock.

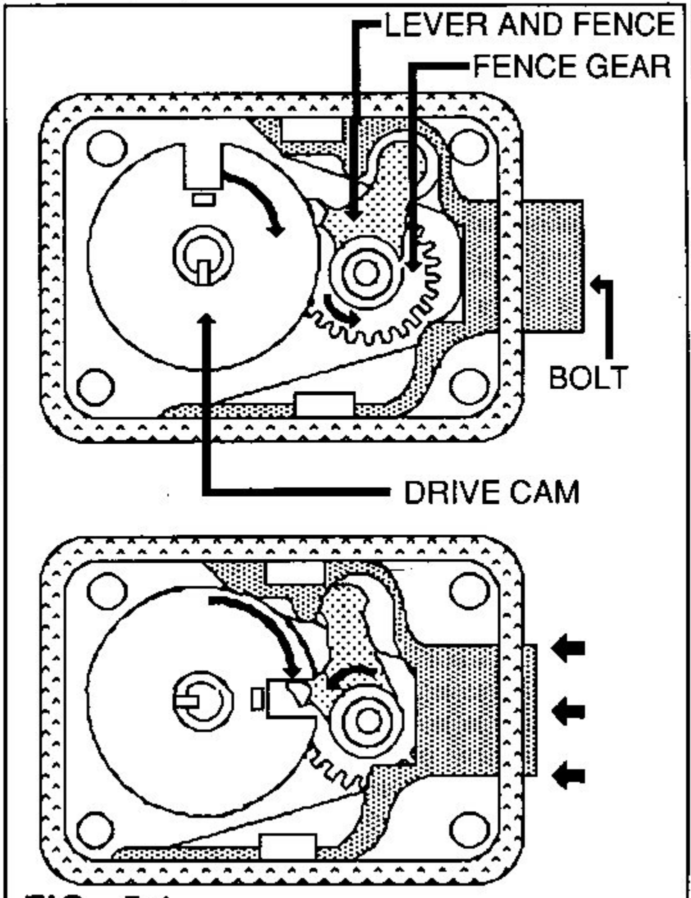


FIG. 5.1

(Refer to chapter two, *finding the number of wheels in the lock.*) Knowing the contact point to be at about 7 (left), the wheel pack should be parked at "left 50." If the wheels are parked using left rotation of the dial, the contact point will not interfere with counting the wheels. Right rotation of the dial will not allow the fence to give indication as the wheels are counted. The Yale lock uses flys and drive pins. This will cause the wheels to pick up at or very close to the chosen pick up point (50 in this case), without the problems caused by fixed drive pins. Repeat this procedure until you are sure of the number of wheels in the lock. We find that our lock has four wheels.

START GRAPH NUMBER "1"

The third step in the manipulation will be to begin the first graph. (See fig. 5.2.) Enter all information in the title block of a standard graph sheet. The wheel action "ALL WHEELS RIGHT" was chosen to begin this manipulation. Using the right contact point graph, enter the nearest whole number in the arrow box (7). The other boxes are numbered: 4, 5, 6 & 8 from left to right.

COLLECT DATA

We begin the graph of the" wheel pack" (all four wheels) by rotating the dial right five times to "0." The dial is then rotated left to the contact point. Approach the contact point carefully.

☞ Note: Grasp the dial with the slightest possible grip when reading the contact point. It should be a sliding grasp that is just enough to move the driver in its bearings, but not enough to move or lift the fence out of the drive cam gate as the drive cam contacts the fence.

Take and record the contact readings around the dial every two and one half numbers. **Take your time**, go for accuracy not speed. **Have confidence**. Take the contact reading carefully, record it accurately and **move along** to the next reading. Do not stop halfway through a graph if a good indication or possible gate indicates. Complete the graph, then return to amplify the indication. Until the graph is completed, you will not have an accurate picture of the wheels.

ANALYZE YOUR DATA

Now that the contact readings around the dial have been taken, connect the dots using a straight edge, as shown in figure 5.2. We now have an accurate representation of the wheel pack. Though there is only one set of contact readings, the readings will give us the same

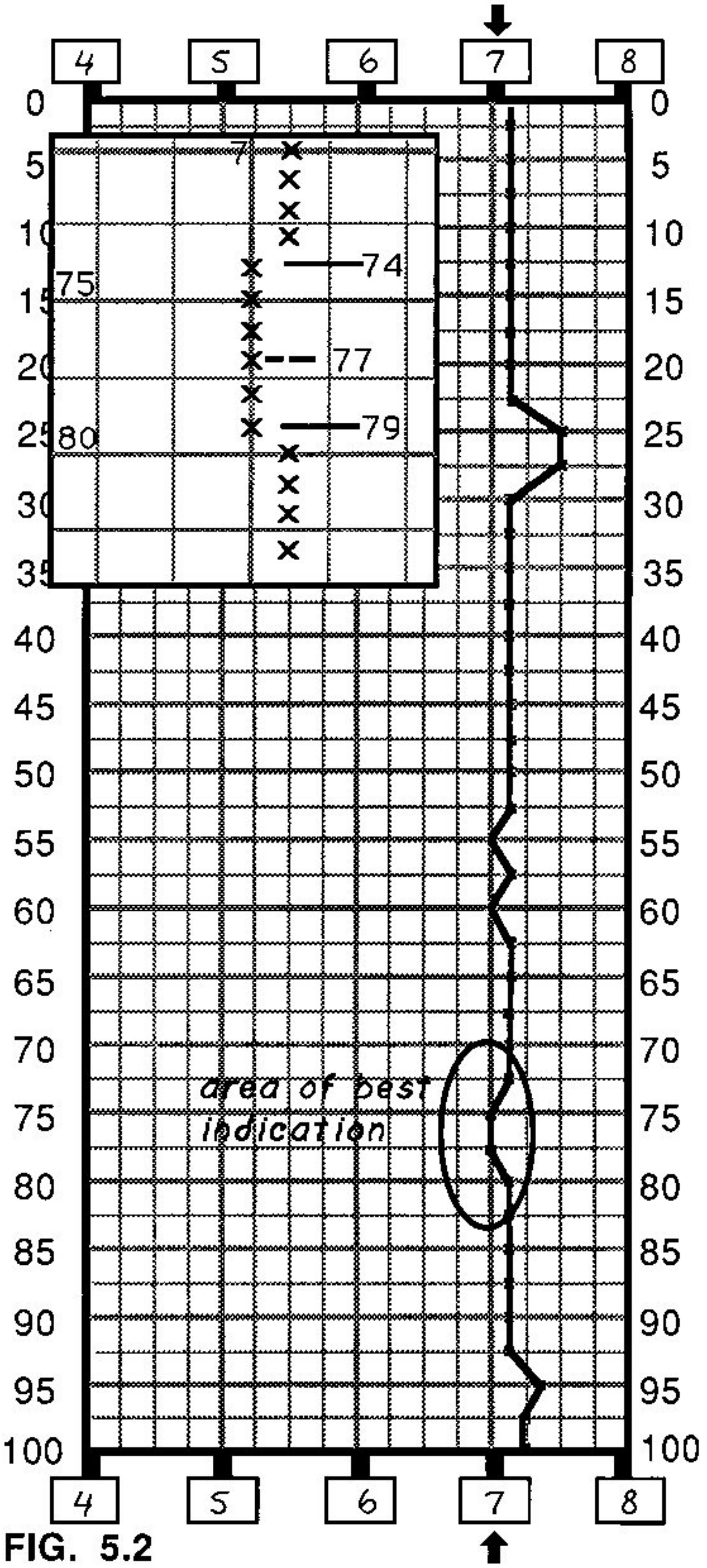
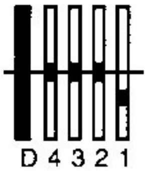


FIG. 5.2

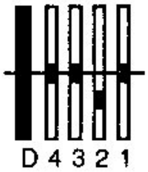
information that two graphs would. As the contact points move left, or toward the center of the page, the wheel pack is indicating a smaller diameter. This will be considered a good indication. The graph indicates two areas of good indication. Both areas were double checked for accuracy and the circled "area of best indication" was chosen, because of its width and resemblance of a gate. (the 1/8th division indication of this graph is evidence of the accuracy of the wheel pack)

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	WHEEL #4 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	87	77	77	77		7	
2	77	87	77	77		7	
3	77	77	87	77		7	
4	77	77	77	87		7 1/8	

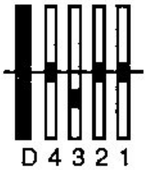
TEST COMBINATIONS



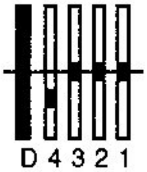
① Turn right 5 times to 87
Turn left 4 times to 77
Turn____ 3 times to _____
Turn____ 2 times to _____
Turn right to contact area, read contact points.



② Turn right 5 times to 77
Turn left 4 times to 87
Turn right 3 times to 77
Turn____ 2 times to _____
Turn left to contact area, read contact points.



③ Turn right 5 times to 77
Turn____ 4 times to _____
Turn left 3 times to 87
Turn right 2 times to 77
Turn left to contact area, read contact points.



④ Turn right 5 times to 77
Turn____ 4 times to _____
Turn____ 3 times to _____
Turn left 2 times to 87
Turn right to contact area, read contact points.

FIG. 5.3

AMPLIFY YOUR INDICATIONS

To further amplify the indications and get a better picture of the suspected gate, it will be necessary to plot the contact points for each number from six or seven numbers above to six or seven numbers below the "area of best indication." The inset (see fig. 5.2) shows an enlarged view of the section of the graph from 70 to 85. By taking contact readings each number, we see that the area of best indication runs from "74" to "79."

FIND THE GATE CENTER

The next step in the manipulation is to find the GATE CENTER for the indicated gate. The graph shows a good indication from "74" to "79." The indication is 5 numbers wide.
(79 - 74 = 5) The center of our indication would be "76 1/2."
(5 ÷ 2 = 2 1/2, 74 + 2 1/2 = 76 1/2)
Since we only have one graph, it isn't necessary to weigh the center of our best indication against the other graph. Select a whole number closest to the center of indication. In the example "77" was chosen as the GATE CENTER.

WHICH WHEEL IS INDICATING?

The next important step in the manipulation will be to determine which wheel is giving the indication of a gate. Trial combinations that selectively throw each wheel away from the gate center will reveal the indicating wheel.

The table of trial combinations shown in figure 5.3 is very much like the tables shown in chapter three. The major difference is that this table is set up for a four wheel lock. Study the table to see that a new column has been added to show the position of wheel number four, a new combination has been added to test wheel number four, all combinations have one more step added to position wheel number four and a small representation of the wheel pack has been added to help you visualize the wheel positioning of each trial combination. Observe that for trial combination number one, the table shows wheels 1, 2, 3 & 4 positioned at 87, 77, 77 & 77 respectively. Trial combination number one begins with five turns right to 87. This will position all wheels at right 87 (the high test number). Left rotation of the dial four times times to 77 will position wheels 4, 3 & 2 at left 77 in that order. Rotate the dial right to the contact area to read the contact point. The representation of the wheel pack to the left of the trial combination is there to help you visualize the wheel positions. The driver (D) is shown as a darkened wheel because its position is not important to the combination. The wheels are labeled 4 3 2 1 in their correct position with respect to the driver.

Remember that the wheel closest to the driver is always the last wheel positioned in the combination (wheel 4 in this case) and the wheel farthest from the driver is always wheel number 1, the first wheel positioned.

The wheel pack representations in figure 5.3 are shown for each trial combination. The gate positions of each wheel, show which wheel is being tested by its trial combination. Reading through the test combination is one thing, but you must be able to **visualize** the wheel positions to understand the test results and draw conclusions from the contact readings obtained.

A second set of test combinations was run, using a low test number of "67." The contact points were the same as those obtained with the high test number. When wheel number four was tested, the contact point jumped up to 7 1/8.

👁

Exercise great care in dialing the test combinations and taking the contact readings. This is the most important step in the manipulation. A mistake at this point will make all further effort fruitless.

*

Once the contact points have been taken, all that remains is to analyze your findings. The table shows that when a test number is placed on wheel number four, the contact point changes from a good indication (7) to a bad indication (7-1/8). The trial combinations will not always give results like those of this manipulation.

*

The indicating wheel will be that wheel which, when tested, shows the greatest change in the contact point (or area).

*

Conclude that wheel number four is set to "RIGHT 77." Enter the conclusion in the remarks block of the graph sheet.

START GRAPH NUMBER "2"

Begin graph number two by filling out a new graph sheet. (See fig. 5.4.) This will be graph number "2." The wheel action will be:

WHEELS 1, 2 & 3 AROUND LEFT
WHEEL 4 AT "RIGHT 77"

Leave the remarks blank open for conclusions to be drawn from this graph.

COLLECT DATA

77 1/2

To begin the graph at "77 1/2" rotate the dial left five times to "77 1/2." This will place all wheels at left "77 1/2." Rotate the dial right two times to "77," to place wheel number four at its known GATE CENTER. Rotate the dial left to the contact area to take and record the contact reading.

80

To take the second contact reading, rotate the dial left from the contact point to one time to 80. As the dial is rotated left from the contact point, the driver will pick up wheel number four at 77, the drive pin of wheel number four will pick up wheel number three and the remaining wheels at 77 1/2 and further left rotation of the dial will position all wheels to "left 80." Rotate the dial right two times to 77 to place wheel number four at its known GATE CENTER. Take and record the contact reading.

☞ Note: It is not necessary to carry the wheels around five times to the test number each time. Study the wheel action using a cutaway lock to fully understand this trick.

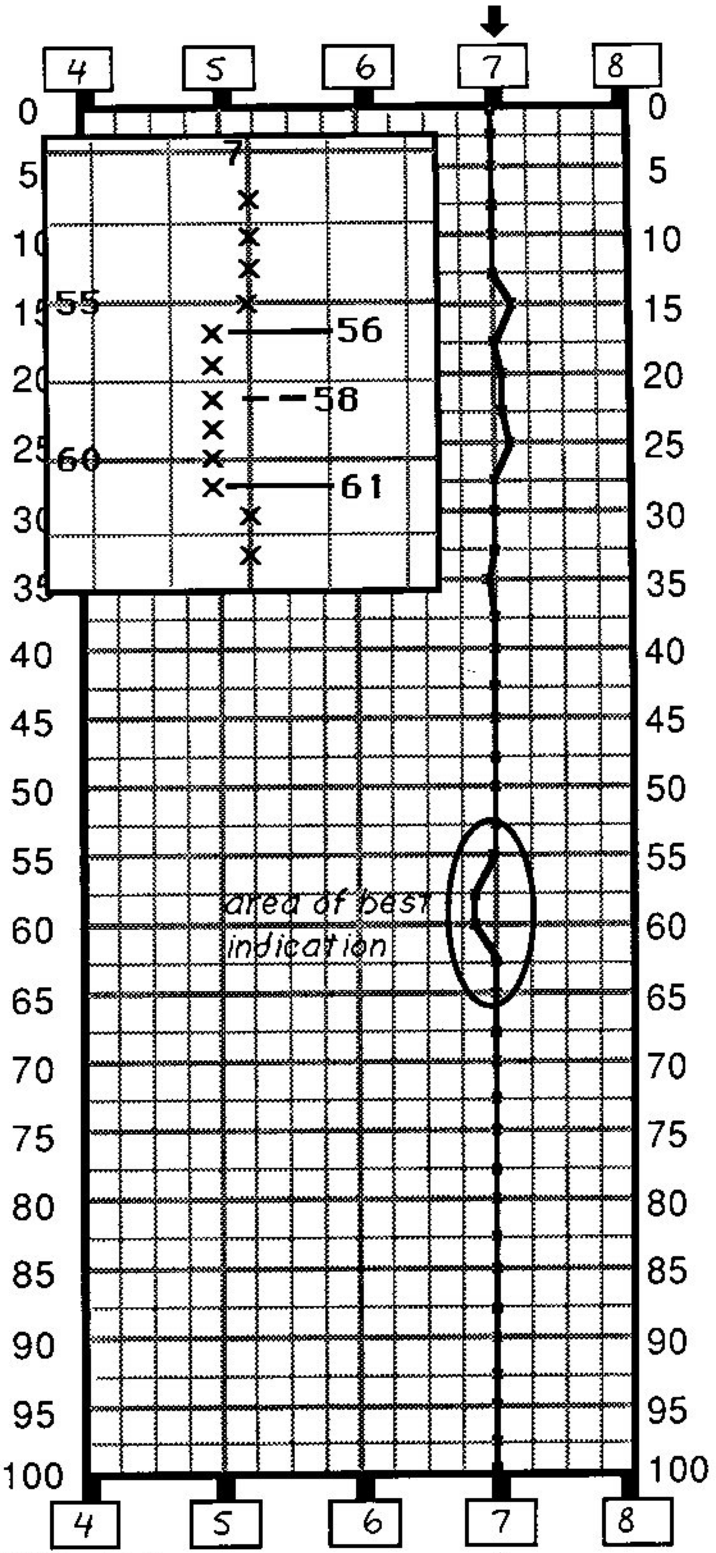


FIG. 5.4

82 1/2 - 75

Use the procedure outlined above to take and record the contact readings around the dial to 75. By beginning the graph at 77 1/2 (the first number left of the known gate) it will be easier to visualize the wheel positions and pick up points.

ANALYZE YOUR DATA

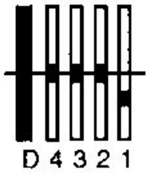
Now that the contact points have been taken, connect the dots using a straight edge, as shown in figure 5.4. What you see is an accurate graphic representation of wheels 1, 2 &3. Again, as the contact points move to the left or toward the center of the page, the wheel pack is indicating a smaller diameter. This will be considered a good indication. The graph indicates an area of good indication between 57 1/2 and 60. The contact points were double checked for accuracy around the area of good indication and the area at 57 1/2 - 60 was chosen as the area of best indication.

AMPLIFY INDICATIONS

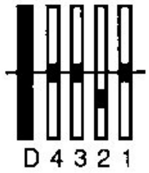
To further amplify the indications and get a better picture of the suspected gate, the contact points for each number from six or seven numbers above to six or seven numbers below the "area of best indication" were plotted on the graph using an "x" to indicate the contact reading. The inset, in figure 5.4,shows an enlarged view of the graph from 50 to 65, showing the contact point readings through the "area of best indication." By amplifying our indications, we find that the area of best indication runs from "56" to "61."

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	WHEEL #4 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	68	58	58	77		6 3/4	
2	58	68	58	77		6 7/8	
3	58	58	68	77		7	
~~4~~							

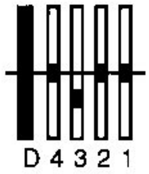
TEST COMBINATIONS



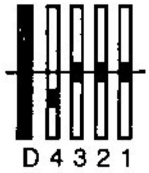
① Turn right 5 times to 68
Turn left 4 times to 58
Turn____ 3 times to _____
Turn right 2 times to 77
Turn left to contact area,
read contact points.



② Turn left 5 times to 58
Turn right 4 times to 68
Turn left 3 times to 58
Turn right 2 times to 77
Turn left to contact area,
read contact points.



③ Turn right 5 times to 58
Turn____ 4 times to _____
Turn left 3 times to 68
Turn right 2 times to 77
Turn left to contact area,
read contact points.



~~④ Turn____ 5 times to _____~~
~~Turn____ 4 times to _____~~
~~Turn____ 3 times to _____~~
~~Turn____ 2 times to _____~~
~~Turn____ to contact area,~~
~~read contact points.~~

FIG. 5.5

FIND THE GATE CENTER

The next step in the manipulation will be to find the GATE CENTER for the indicated gate. The graph, figure 5.4, shows a good indication from "56" to "61." This indication is 5 numbers wide. (61 - 56 = 5) The center of our indication would be "58 1/2." (5 ÷ 2 = 2 1/2, 56 + 2 1/2 = 58 1/2) We have selected "58" as the GATE CENTER. (nearest whole number to the center of our best indication)

WHICH WHEEL IS INDICATING?

The next important step in the manipulation will be to determine which wheel is giving the indication of a gate. Trial combinations that selectively throw each wheel away from the GATE CENTER will reveal the indicating wheel. The table of trial combinations shown in figure 5.5 contains: the known GATE CENTER for wheel number four, the GATE CENTER for the unknown wheel and the high test number "68."

The trial combinations have been set up to properly position the wheels using the information contained in the table. After working the trial combinations, the contact points clearly indicate that wheel number three is the indicating wheel. A test table and set of trial combinations was also worked using a low test number of "48." The test results were the same. Conclude that wheel number three of the lock is set to "58." Enter the conclusion in the remarks block of graph sheet number two.

START GRAPH NUMBER "3"

Begin graph number three, figure 5.6, by filling in the blanks at the top of a new graph sheet. Graphs and test combinations worked in previous steps have given us the positions of wheels number three and four. This graph will use the gates of the known numbers as a window, through which to graph the remaining wheels. Observe that the contact point progressed from 7 1/8 to 7 in the first graph and from 7 to 6 7/8 in the second graph. The wheel action for this graph will be:

WHEELS 1 & 2 AROUND RIGHT

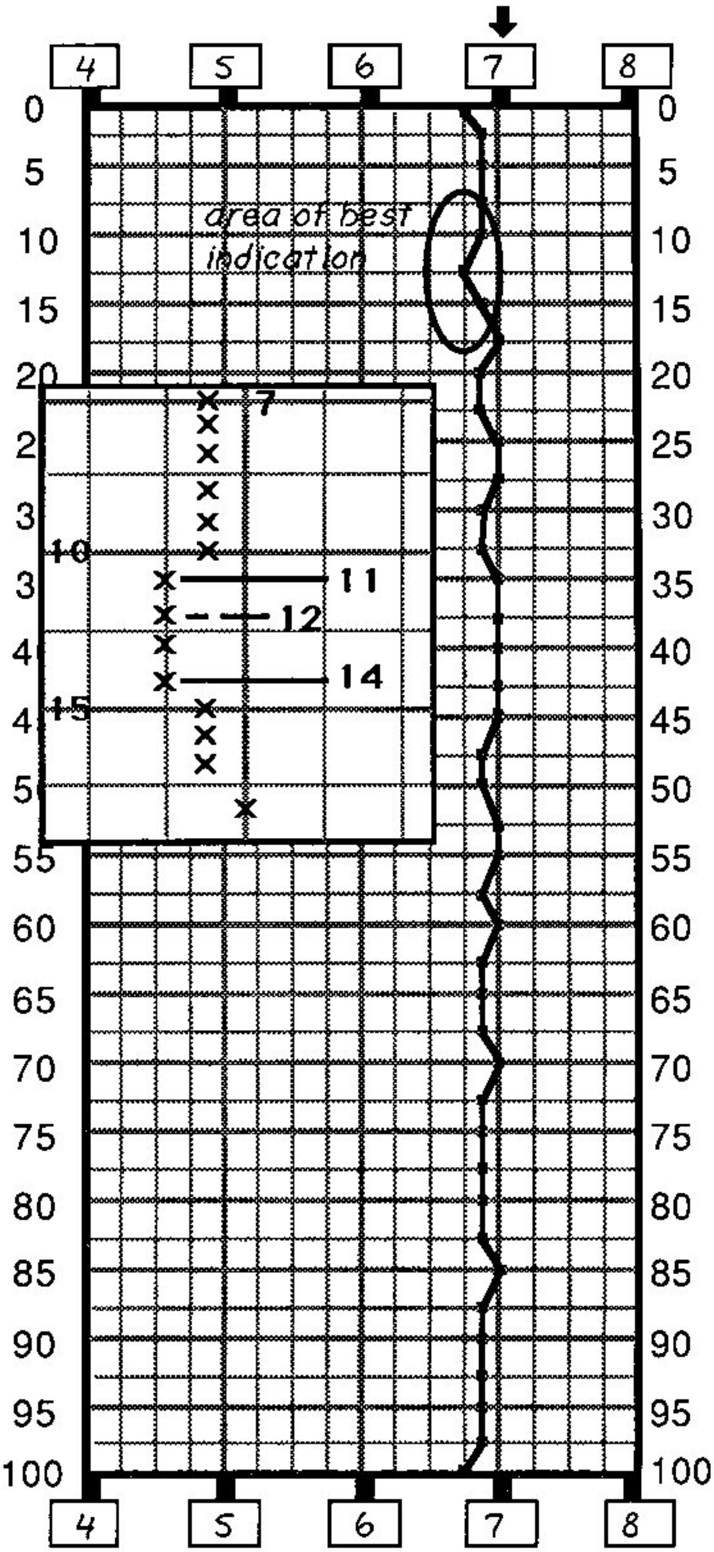


FIG. 5.6

WHEEL 3 AT LEFT 58
WHEEL 4 AT RIGHT 77

Leave the remarks blank open for conclusions to be drawn from this graph.

COLLECT DATA

55

Begin the graph at "55" by rotating the dial five times right to "55." This will place all wheels at right "55." Rotate the dial left three times to "58" then right two times to "77" to place wheels three and four at their known gate positions. The wheel pack now rests with wheels one and two at right 55, wheel three at left 58 and wheel four at right 77. Dial left to the contact area to take and record the contact point.

52 1/2

Since we know the position of the wheels from the last step, taking the next contact reading will be easy. Rotate the dial right, from the contact point, to 77. At this point wheel number four will pick up, and be carried around right. Continue around right to 58, where wheel number three will pick up and begin moving around right. Continue around right to 55 to pick up the remaining wheels. All four wheels are now moving around right. Move the dial right only 2 1/2 numbers from 55 to properly position all wheels at right 52 1/2.

If you follow this wheel action, you will understand why it is only necessary to rotate the dial a little over one turn to pick up and move all four wheels to the next test number. Practice this with a cut away lock. Don't waste time spinning your wheels, use your knowledge of the wheel action to place them. It will save you time over the course of a manipulation.

Dial left, three times to 58 then right two times to 77. This will return wheels three and four to their known gate positions. Rotate the dial left to the contact area to take and record the contact point.

50 - 57 1/2

Follow the procedure outlined above to take and record the remaining contact points around the dial.

ANALYZE YOUR DATA

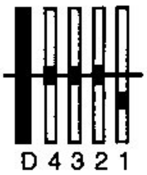
Now that the contact points have been taken, connect the dots using a straight edge, as shown in figure 5.6. What you see is an accurate graphic representation of wheels 1 & 2, with wheels 3 & 4 being held at their known gate positions. The best indication of the graph is found to be at "12 1/2," with a contact point at "6 3/4." Other areas of good indication should be double checked, to insure the accuracy of our findings. The area from "10" to "17 1/2" was chosen as the "area of best indication.

AMPLIFY YOUR INDICATIONS

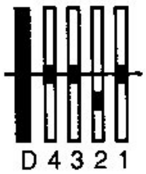
To further amplify the indications and get a better picture of the suspected gate, the contact points for each number from six or seven numbers above to six or seven numbers below the "area of best indication" should be plotted on the graph. Use an "x" to indicate the contact points. The inset, in figure 5.6, shows the contact point readings through the area of best indication. By amplifying the indications, we find that the area of best indication runs from "11" to "14."

Wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	WHEEL #4 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	22	12	58	77		6 3/4	
2	12	22	58	77		6 7/8	
~~3~~							
~~4~~							

TEST COMBINATIONS



① Turn *left* 5 times to 22
Turn *right* 4 times to 12
Turn *left* 3 times to 58
Turn *right* 2 times to 77
Turn *left* to contact area, read contact points.



② Turn *left* 5 times to 12
Turn *right* 4 times to 22
Turn *left* 3 times to 58
Turn *right* 2 times to 77
Turn *left* to contact area, read contact points.

~~③ Turn____ 5 times to _____~~
~~Turn____ 4 times to _____~~
~~Turn____ 3 times to _____~~
~~Turn____ 2 times to _____~~
~~Turn____ to contact area, read contact points.~~

~~④ Turn____ 5 times to _____~~
~~Turn____ 4 times to _____~~
~~Turn____ 3 times to _____~~
~~Turn____ 2 times to _____~~
~~Turn____ to contact area, read contact points.~~

FIG. 5.7

FIND THE GATE CENTER

The next step in the manipulation will be to find the GATE CENTER for the indicated gate. The inset (fig. 5.6) shows the indicated gate from "11" to "14." The gate indication is 3 numbers wide.(14 - 11 = 3) The center of indication is 12 1/2.
(3 ÷ 2 = 1 1/2, 11 + 1 1/2 = 12 1/2)
We have selected 12 as the GATE CENTER.
(nearest whole number to the center of indication)

WHICH WHEEL IS INDICATING

The next important step in the manipulation will be to determine which wheel is giving indication. As before, it will be necessary to set up a table of test combinations that will selectively throw each wheel away from the GATE CENTER. As you can see from the table in figure 5.7, wheels three and four have not been tested. Trial combinations three and four, and lines three and four of the test table have been lined-out, because the gate locations for these wheels are known. A high test number of 22 was chosen and entered into the table. The GATE CENTER and known gates were entered in the appropriate boxes. The trial combinations were filled out using the information from the test table.

The contact points for trial combinations one and two indicate that wheel number two is the indicating wheel.

1. When the high test number was placed on wheel number two, the contact point was farthest from the good indication.
2. When the high test number was placed on wheel number one, the good indication remained.

A test table and trial combinations was set up using a low test number of "2." Contact points were taken using the trial combinations, with the same results. Wheel number two was revealed as the indicating wheel. Enter the conclusion, in the remarks box of graph sheet number three, that wheel number two is set at right "12."

Always run a high and low set of test combinations as a self check. When the lock is indicating by only an eighth of a number, it is a good idea to recheck the indications to make sure that the readings are accurate.

START GRAPH NUMBER "4"

Start graph number four by filling out the blanks at the top of a new graph sheet. (See fig. 5.8.) Graphs and test combinations worked in previous steps have given us the positions of wheels number two, three and four. This graph will use the information gained in previous steps to position these wheels at their known gates as the last wheel is moved around left to find its' unknown gate. Note that the contact point has moved from 6 7/8 to 6 3/4 in the last graph. The wheel action for this graph will be:

WHEEL 1 AROUND LEFT
WHEEL 2 AT RIGHT 12
WHEEL 3 AT LEFT 58
WHEEL 4 AT RIGHT 77

Leave the remarks blank open for conclusions to be drawn from this graph.

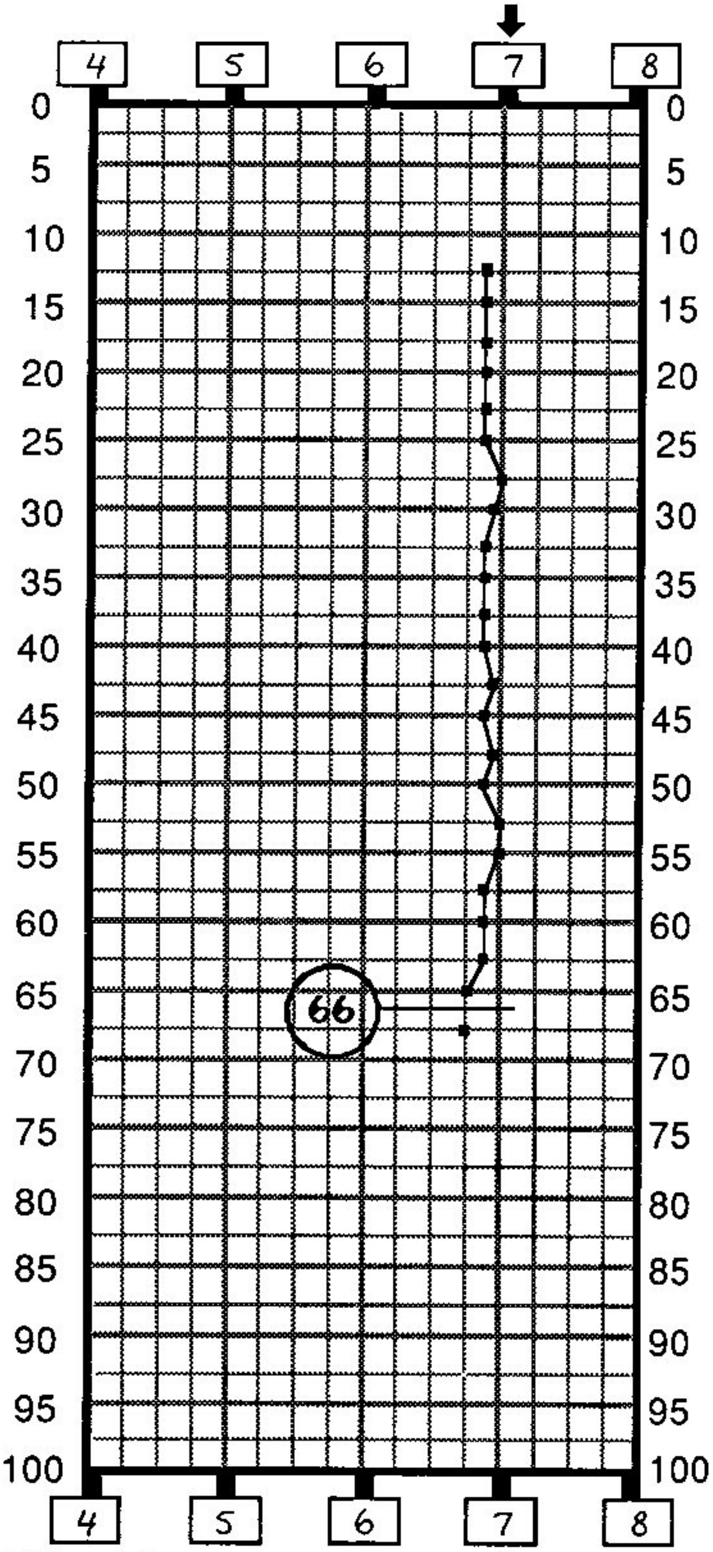


FIG. 5.8

COLLECT DATA
12 1/2

Begin the graph at "12 1/2" by rotating the dial five times left to "12 1/2." This will place all wheels at left "12 1/2." Rotate the dial right four times to "12." This will place wheel number three at right 12 while leaving wheel number four at left 12 1/2. Rotate the dial left three times to "58" then right two times to "77" to place wheels three and four at their known gate positions. The wheel pack now rests with wheel one at left 12 1/2, wheel two at right 12, wheel three at left 58 and wheel four at right 77. Dial left to the contact area to take and record the contact point.

15

Move wheel number one to its next position by rotating the dial left only four times to 12 1/2. This will pick up all wheels. Continue left 2 1/2 numbers to 15 to place wheel number one at its proper position. Dial right four times to 12, left three times to 58 and right two times to 77 to place wheels two, three and four at their known gate positions. Rotate the dial left to the contact area to take and record the contact point.

17 1/2 - 10

Follow the procedure outlined above to take and record the remaining contact points around the dial.

As you can see, it was not necessary to take contact readings around the dial. The safe was opened at "67 1/2." The indicator at "66" shows the actual setting of the wheel. This was found after the safe was opened.

Very few things in this life have the lasting value that accomplishment brings. Accomplishment is the fuel for further accomplishment. Success in one endeavor gives us the confidence and drive to succeed in the next. Learning the art and practice of manipulation breeds the kind of personal confidence that will allow you to succeed in almost any endeavor.

If you do not give up, you will not fail.

WHAT IF ?

In some instances the fence will find the gate in the last wheel by use of the graphing technique, but will not allow the lever to fall far enough to withdraw the bolt. A drastic decrease in the contact area will be noticed , but the safe refuses to be opened. Oscillate the dial rapidly in the contact area to make the fence move the combination wheels, allowing it to enter the gates.

If this does not allow the safe to be opened, graph the last wheel one number at a time from five numbers above the best indication to five numbers below the best indication. Holding the other wheels at their known gate positions. This will give you a good indication of the gate location. If the safe does not open, find the GATE CENTER for the last wheel and proceed with the next step.

Run a short graph for each known number using the same technique as above. Graph each wheel from five numbers above to five numbers below the known gate number. Hold the wheels not being tested at their same positions. Using your knowledge of wheel action, it is possible to move each wheel independently of the others. (i.e., Move wheel two, one number at a time, from 17 to 7 while holding wheel one at 66, wheel three at 58 and returning wheel four to 77 each time.) Change the GATE CENTERS if the indications are different from your original ones.

If you still find that you cannot open the safe, it will be necessary to review the graphs to this point. It is possible that in graph number one, we determined that the gate was at "77" when actually it was at or near 55 or 60. Run a short graph, every number, through the area of good indication on the suspect wheel, holding the remaining wheels at their points of best indication.

To obtain useful information from your

graphs, move only one wheel at a time. By varying the position of wheel two only or wheel three only, the graph will represent the outline of that wheel alone.

REVIEW YOUR PROGRESS

1

Take a moment to review and consider what steps we have followed to bring us to the conclusion of this manipulation.

1. Determine the type of fence.
2. Locate and define the contact area or point.
3. Find the number of wheels.
4. Fill out and begin the first graph.
5. Collect data.
   Take contact readings of the wheel pack around the dial.
6. Analyze data.
   Determine the area of best indication.
7. Amplify indications.
   Take contact readings above and below the area of best indication.
8. Find "GATE CENTER."
9. Determine which wheel is indicating, using high and low test combinations.

2

10. Fill out and begin graph number two.
11. Collect data.
    Take contact readings of wheels three, two and one, using information gained in the above steps to set wheel four at its known gate.
12. Analyze data.
    Determine the area of best indication.
13. Amplify indications.
    Take contact readings above and below the area of best indication.
14. Find "GATE CENTER"
15. Determine which wheel is indicating, using high and low test combinations.

3

16. Fill out and begin the third graph.
17. Collect data.
    Using information gained in the first two graphs, take contact readings of wheels two and one around the dial.
18. Analyze data.
    Determine the area of best indication.
19. Amplify indications.
    Take contact readings above and below the area of best indication.
20. Find the "GATE CENTER"
21. Determine which wheel is indicating, using high and low test combinations.

4

22. Fill out and begin the fourth graph.
23. Collect data.
    Using information gained in the first three graphs, take contact readings of wheel one around the dial.

At this point the safe was opened. Had it not opened, the following steps would have been followed.

24. Analyze data.
    Determine the area of best indication.
25. Amplify indications.
    Take contact readings above and below the area of best indication.

24. Find the "GATE CENTER"
25. Determine which wheel is indicating, using high and low test combinations.
26. Check the "GATE CENTER" for other

wheels, one at a time, by graphing contact points (each number) from five numbers above to five numbers below the gate center number.

27. Review the graphs.
    If there are areas of good indication, test them using the gates you are sure of. Don't limit your testing to only five numbers above and below.
28. Hold three wheels (those that gave the best indication) and run a graph on the other wheel.
29. If the graph does not show a gate at another position on the wheel, assume that the first indication was correct and graph another wheel.
30. If no results are obtained, after running a graph on each wheel independently, consideration must be given to other means of opening the safe.
31. Inform the customer that it will be necessary to use other means to open the container **before** you continue. (details of "remove, repair and replace" costs or additional charges must be agreed to in advance to avoid confusion and dispute)

STUDY QUESTIONS

The following questions and exercises are designed to test your understanding of the material covered and reinforce some of the more important points. These questions are to stimulate thought and increase your understanding of the concepts and ideas presented. Study them carefully.

1. When counting the wheels in a friction fence type lock, explain the advantage of picking up the wheels with right rotation of the dial.

2. What significance do the illustrations on the test combination work sheet have to the test combinations?

3. What are the major changes in the four wheel test combination work sheet over the three wheel work sheet?

4. You will note that some of the blanks in test combination work sheet number one were left blank. Using the wheel action, tell why these steps are correct.

5. When analyzing the test results of the trial combinations, what distinguishes the indicating wheel from the other wheels?

6. After running all the graphs and determining GATE CENTERS for all the wheels, you find that the safe remains locked. What steps should you follow to complete the manipulation and open the safe?

For study question answers, see page 136.

NOTES

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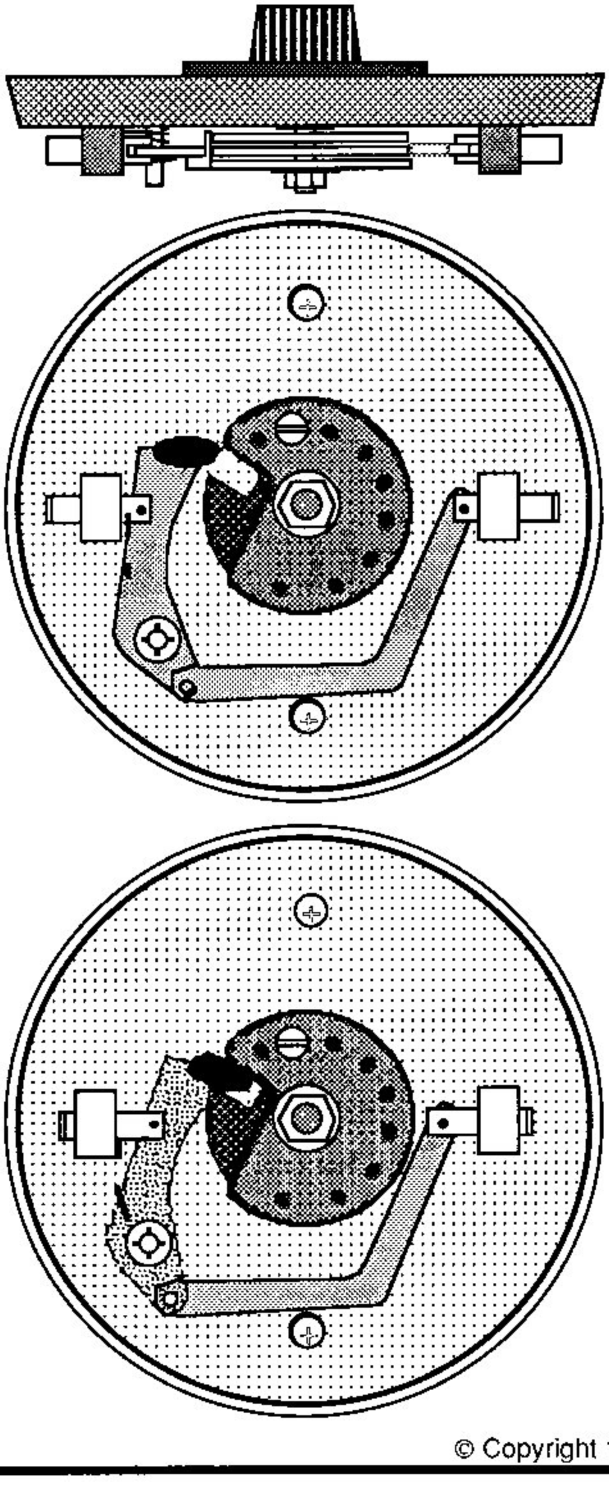
Chapter Six

The Sentry Floor Safe

THE SENTRY FLOOR SAFE

Introduction to the Sentry floor safe.



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THE SENTRY FLOOR SAFE

GOALS

1. Upon completion of this chapter, you will understand the operation of the lock and bolt-works of the SENTRY floor safe.
2. Upon completion of this chapter you will understand what makes the SENTRY floor safe relatively easy to manipulate.

DOOR CONSTRUCTION

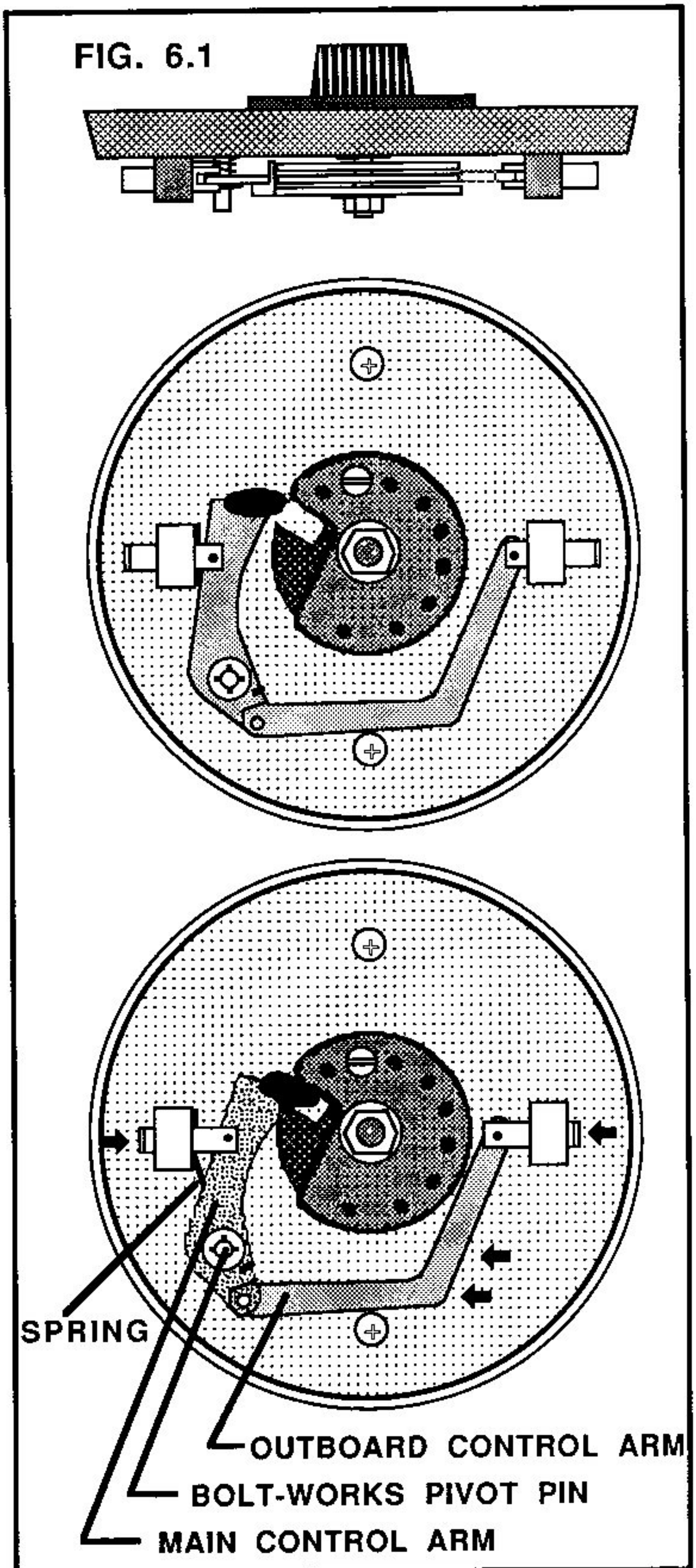
This safe has a mild steel door without a hard plate, and is not a tool resistant container. Though the door might be easy to drill, it is still easier to manipulate because of the lock design.

From the diagram (fig. 6.1) you will see that this safe has only two combination wheels. The wheels are of the "no change" type.

The drive cam is a screw change nylon wheel, with nine possible positions for the drive pin (screw). This will allow the combination to be set to any of nine positions around the dial. Each change in the position of the drive pin will index the combination by ten numbers on the dial. If the original combination was;

L3T-23, R2T-68, L-35 then a change in the position of the drive pin one hole right of its present position would make the new combination L3T-33, R2T-78, L-35. The spread between the first two numbers of the combination is fixed and will not change. The drop-in point of the drive cam does not change. If the customer has changed the combination, ask if the old combination is available. By adding multiples of ten to the first two numbers of the old combination, the safe can be opened.

FIG. 6.1



Observe the bolt-works of the door. The main control arm is spring loaded by a coiled torsion spring. The torsion spring is wound on the bolt-works pivot pin and hooks over the main control arm just below and to the right of the pivot pin. The other end of the torsion spring bears on the inside of the bolt guide block. This spring causes the fence and main control arm to be loaded toward the wheel pack. As the proper combination is dialed, the spring causes the fence to enter the wheel pack. As the fence enters the wheel pack, the main control arm, moving toward the wheel pack, retracts its lock bolt, and by way of the outboard control arm, the outboard lock bolt. The door is opened. Study the diagram on page 81, it is ingeniously simple and uses an absolute minimum number of moving parts.

OPENING SPREAD / GATE WIDTH

The fence of this lock is an 1/8" round rod. The width of the wheel gates and the width of the fence allows the safe to open over a five number spread. If, as in the previous example, the original factory combination was;

LEFT, 3 TIMES TO 23
RIGHT, 2 TIMES TO 68
LEFT, 1 TIME TO 35

the safe will open equally well using combinations from L-21, R-65,L-35 to L-25, R-70, L-35.

The major advantage gained by this knowledge is that the lock graph may be run using a five number movement of the wheel pack in place of the 2 1/2 number movement used in previous graphs. It is only necessary to take twenty contact readings around the dial to locate a gate.

INDICATIONS

The gate will indicate 1/2 to a full number and is almost as easily felt as it is read by the contact points. As the fence drops into a wheel gate, the contact points will become more solid than if a gate is not under the fence. Two out of three safes will indicate on wheel number two first. If the combination is worked in a LEFT-RIGHT-LEFT sequence, the difference between the first and second numbers will always be between 35 and 75 numbers.

PROCEDURE

1

1. Locate and define the contact area. It may be necessary to construct a temporary opening index on the door to more accurately take your contact readings, as the manufacturers opening index does not lend itself well to accurate measurements.
2. Fill out and begin the first graph.
3. Collect data. Take contact readings around the dial every "5" numbers. (20 contact readings, use ALL WHEELS RIGHT wheel action.)
4. Analyze the data. Determine the area of best indication.
5. Amplify indications. Take contact readings above and below the area of best indication.
6. Find the "GATE CENTER".
7. Determine which wheel is indicating, using test combinations.

2

8. Fill out and begin the second graph, using information gained in step one.
9. Collect data. Take contact readings around the dial every "5" numbers.

The safe will be opened in step nine if the first section of the procedure was carried out accurately, and the door is in proper working order.

WHAT IF?

If the safe is not opened in step nine, it will be necessary to continue with the manipulation process.

10. Analyze data. Determine the area of best indication.
11. Amplify indications. Take contact readings above and below the area of best indication.
12. Find the "GATE CENTER".
13. Recheck the other gate center.

At this point, the contact area will or should have decreased significantly. Intuition would tell us that the proper combination has been worked, and the safe has another problem that is not allowing the bolts to be retracted.

Oscillate the dial rapidly against the left contact point (the hard side of the contact area). If this does not cause the bolts to be retracted, it is possible that rust in the bolt guide blocks is keeping the bolts extended. Work the proper combination, then, using a hardwood block and hammer, jar the door immediately above the guide blocks. This should dislodge the bolts and allow the safe to be opened.

In figure 6.1, the two Phillips head screws extend through the door to attach the end caps of the lift handle.
(lift handle not shown in side view)
The bolt guide blocks are on either side of the lift handle.

A WORD OF CAUTION !

Though this safe may be slightly easier to open than some other types, don't underestimate its ability to keep you out. In its price range, this is a well built little safe. The standard charge to manipulate it may approach its original cost, but it should be manipulated not drilled.

The only recommendation that I would make, is that the student obtain one of these safes to practice on before meeting one in the field. **Experience is the best teacher.**

*

Learn at home.
Practice in the field.

*

STUDY QUESTIONS / EXERCISES

The following questions and exercises are designed to test your understanding of the material covered and reinforce some of the more important points. These questions are to stimulate thought and increase your understanding of the concepts and ideas presented. Study them carefully.

1. What action retracts the door bolts on the Sentry Floor Safe?

2. How many contact readings are necessary to graph 360° of wheel rotation? (40, 25, 20)

3. Using fig. 6.1, tell how many different combinations this safe can be set to.

What two things do all these combinations have in common?

If we have the original combination, what do we know about all possible combinations?

4. The most common "spread" between the first and second numbers of the combination is between _______ and _______.

5. The door has two through holes, where?

For study question answers, see page 136.

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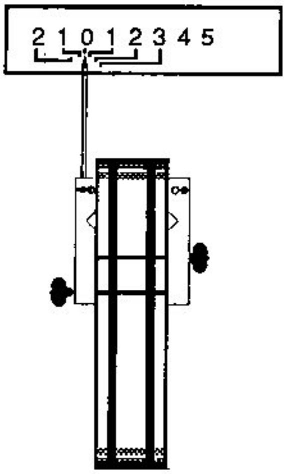
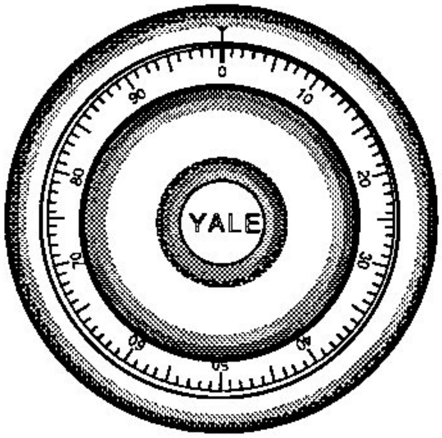
Chapter Seven

The Straight In or Direct Entry Fence

THE STRAIGHT IN
OR
DIRECT ENTRY FENCE

Manipulation techniques introduced
A manipulation tool is introduced




0
10
20
30
40
50
60
70
80
90
YALE

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THE STRAIGHT IN
OR
DIRECT ENTRY FENCE

GOALS:

1. Upon completion of this chapter, you will be familiar with the direct entry or straight in fence type lock.
2. Upon completion of this chapter, you will be familiar with some of the special techniques used to manipulate this type of lock.
3. Upon completion of this chapter, you will be familiar with the "false gate", and a procedure for defeating it.

INTRODUCTION

As you recall, the direct entry fence type lock has no lever or bolt. (See fig. 7.1.) The fence is an integral part of the bolt bar. The position of the wheels in the wheel pack will directly prevent the bolts from being withdrawn. Force applied to the opening handle causes the fence to bear directly on the wheel pack. False gates in the drive cam are very common in this type of lock.

****

DETERMINE THE TYPE OF LOCK

The first step in our manipulation will be to determine the type of lock (fence). Left and right rotation of the dial reveals no contact points. As the dial is rotated, the combination wheels can be felt and heard as they pick up, but no contact points are to be found. Torque applied to the opening handle in the opening direction immediately causes the drive cam to bind. Rotation of the dial with force applied to the opening handle, causes the drive cam to "lock up" at one or more positions around the dial. This is most probably a straight in or direct entry type lock.

THE DIRECT ENTRY FENCE

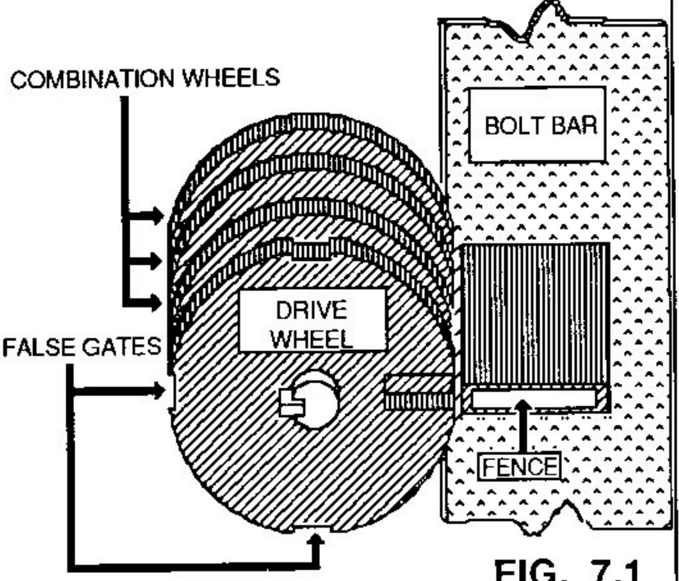


FIG. 7.1

HOW MANY WHEELS ?

The second step in the manipulation will be to determine the number of combination wheels in the lock. (Refer to chapter two, *finding the number of wheels in the lock* .) Use the standard method for finding the number of wheels in the lock. Because there are no contact points to confuse with the wheel pick-up sounds, it should be fairly easy to count the wheels.

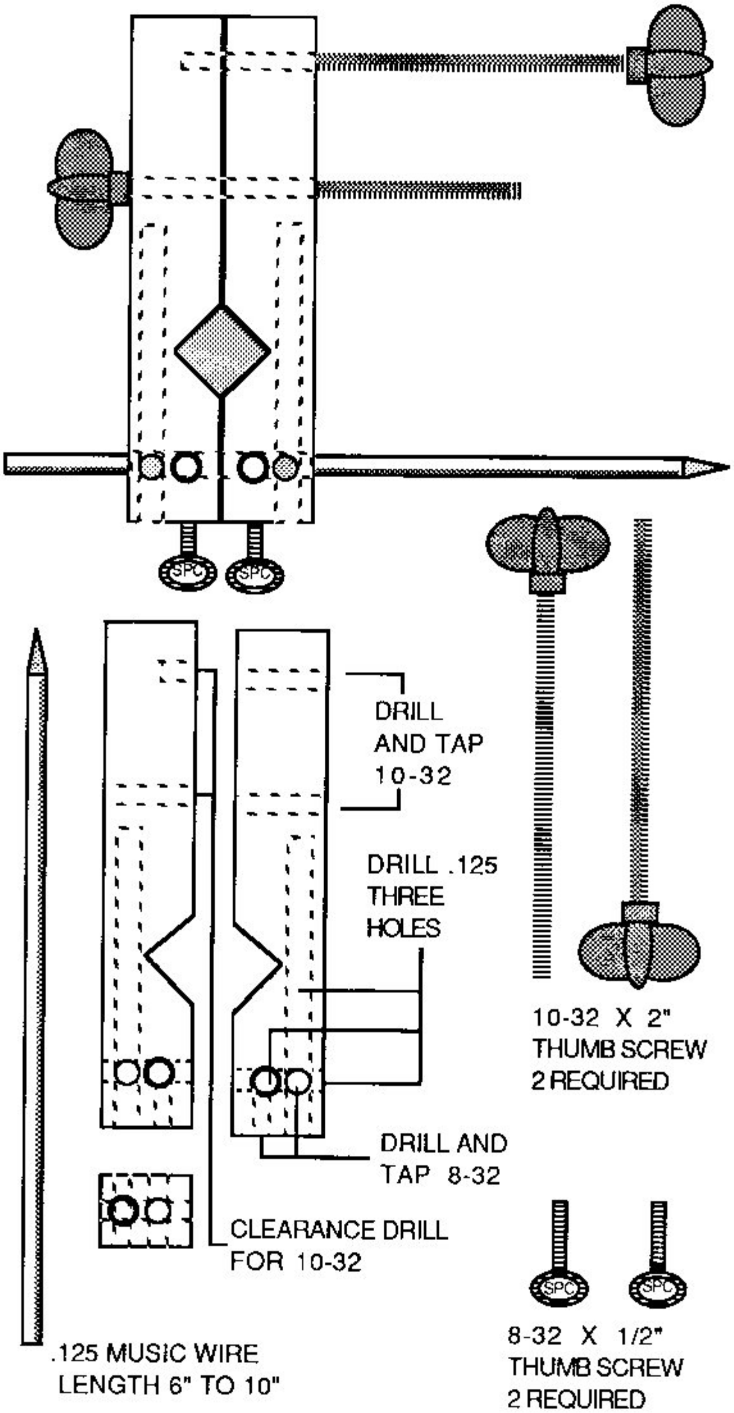
One major consideration must be observed as the wheels are counted. These locks will most usually have fixed drive pins. If the wheel pack is parked at right "50", for example, the wheels may pick up ahead of or behind the park point. (See chapter four, *the fixed drive pin lock* .)

A NEW TOOL

As you can see from the construction of this lock, taking conventional left and right contact readings of the drive cam gate would give no indication of the changes in the diameter of the wheel pack. Penetration of the fence into the wheel pack must be measured using the motion of the opening handle to indicate the diameter of the wheel pack. When a wheel gate or low spot in the wheel pack is present under the fence, the movement of the fence will be revealed by the amount of movement of the opening handle.

Figure 7.2 shows a tool that will allow the manipulator to attach a pointer to the opening handle of most safes. Basically this is a machinist clamp with a "V" jaw for clamping to round or irregular shaped handles. If the tool is clamped to the base of the handle, the pointer will lay close to the face of the door, making it easier to see the differences in the contact readings. The pointer is made of music wire. Bend the pointed end slightly so that it can be adjusted close to the surface of the door.

The clamp is designed to hold the pointer securely, in any direction. (See fig. 7.3.) This tool makes a nice little project and a necessary addition to your tool kit. Grade 5 socket head cap screws may by substituted for the thumb screws.



TOOL BODIES
2 PIECES 1/2" X 1/2" X 2 3/4"

FIG. 7.2

START GRAPH NUMBER "1"

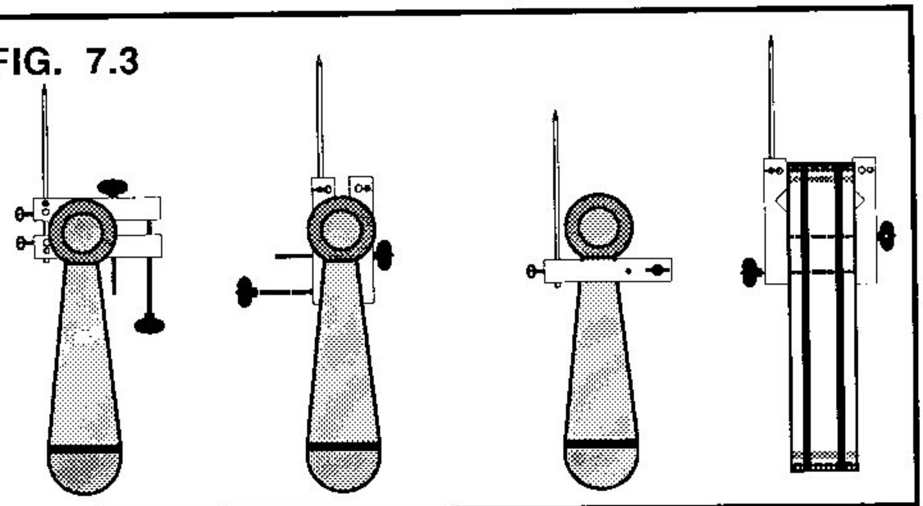
This will be a single graph format because there is only one contact point to be plotted. The exact position of the opening handle, as it causes the fence to contact the wheel pack, will be plotted every two and one half numbers around the dial. The contact point will move in the opening direction as a gate or low spot in the wheel pack allows the handle to move farther in the opening direction.

There are two major considerations that must be discussed before you begin taking contact readings. The first is the amount of torque applied to the opening handle. The second will be how to handle the false gate indications.

In order to insure that the same amount of torque is applied to the opening handle each time a contact reading is taken, we will attach a rubber band from the opening handle to the edge of the door or side of the safe. (See fig. 7.4.) Fashion a hook from a piece of stout wire to hold the rubber band to the edge of the safe door. Use a wide rubber band to give a good pull on the handle. Turn the handle in the locking direction to position the wheel pack, then release the handle allowing the rubber band to apply pressure to the wheel pack as you take the contact reading. Great force is not necessary to get good contact readings.

The second obstacle that you will most probably face is the presence of false gates in the drive cam. This is a confusion tactic and does not effect the contact readings. It makes no difference to the contact readings if they are taken at the true gate or through a false gate. If you chose a position of the dial to take the contact readings, use the same position each time.

FIG. 7.3



CONSIDER THIS:

As the fence approaches the wheel pack at a false gate position, one of two conditions must exist.

1. The fence is resting on the wheel pack and will give true readings.
or

2. The fence is resting on the drive cam. and will not give true readings.

If the fence is resting on the wheel pack, proceed to take and record the contact reading. If the fence is resting on the drive cam it will bind the dial and you will feel the fence rub on the bottom of the false gate. When the fence touches the drive cam, chose another gate. Feel for the bottom of the false gate each time a contact reading is taken.

COLLECT DATA

Attach a piece of paper tape to the safe door, under the tip of the pointer, as shown in figure 7.4. Mark off 1/8" increments on the tape to indicate the movement of the handle. Each of these increments will represent the vertical lines of the graph. Label the first contact point "0". All lines in the opening direction will be"+". Lines toward the locking direction are "-".

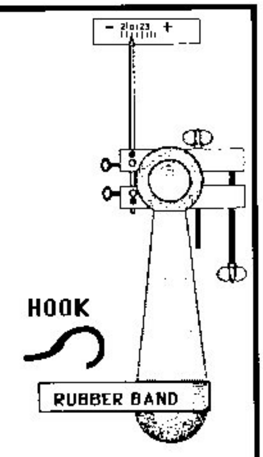


FIG. 7.4

Take contact readings around the dial with an all wheels one direction wheel action to find the first wheel gate.

Follow the same procedures used in previous manipulations to open the safe.

CAUTION:

Fixed drive pins can pick up and displace a parked wheel. Feel for the wheel pick-up. Know which wheels are being moved and which ones are not.

SENTRY FIRE SAFE

The SENTRY fire safe is a two wheel direct entry type lock. (See Chapter "6") Use a 2 1/2 number graphing sequence. Wheel number two will usually indicate first. False gates and fixed drive pins will be found in these locks. A common problem with these containers is moisture in the insulation material swelling the door. The bolt works becomes displaced from the door and blocks on wheel number one. When the proper combination is worked, the lock bolt will not retract with the handle. Dial the proper combination and drill from the side to drive the bolt back and free the door.

STUDY QUESTIONS

The following questions and exercises are to test your understanding of the material covered and reinforce some of the most important concepts.

1. What effect do false gates have on the manipulation resistance of this type of lock?

Explain how it is possible to take contact readings through a false gate.

2. Why is turning torque so important to the manipulation of this lock?

3. Explain why contact readings taken from the dial would be of no use in the manipulation of this type of lock.

4. Acquire a Sentry fire safe and practice taking contact readings. Run a graph every two and one half numbers around the dial.

a. Did both gates indicate on the same graph?
b. What was the amount of indication? (1/32", 1/16", 1/4" ?)

Try reading the contact points using a false gate.

c. Did this effect the contact readings?
d. How long did you take to read 40 contact points in this manner? (15-20 min.?)

If both gates are located in the first graph, position wheels one and two at their suspected gate locations using the same direction of rotation. (see page 58 for this procedure) Check all false gates as the drive cam is rotated in the opposite direction back to where you feel wheel number two pick up. If the safe is not opened, reverse the numbers for wheels one and two and repeat the procedure. (If you tried "#X" on wheel one and "#Y" on wheel two, then try "#Y" on wheel one and "#X" on wheel two.) One graph and two trial combinations will open about 50% of these safes.

Practice this procedure before answering the last question.

5. Can you see any reason to drill this type of safe?

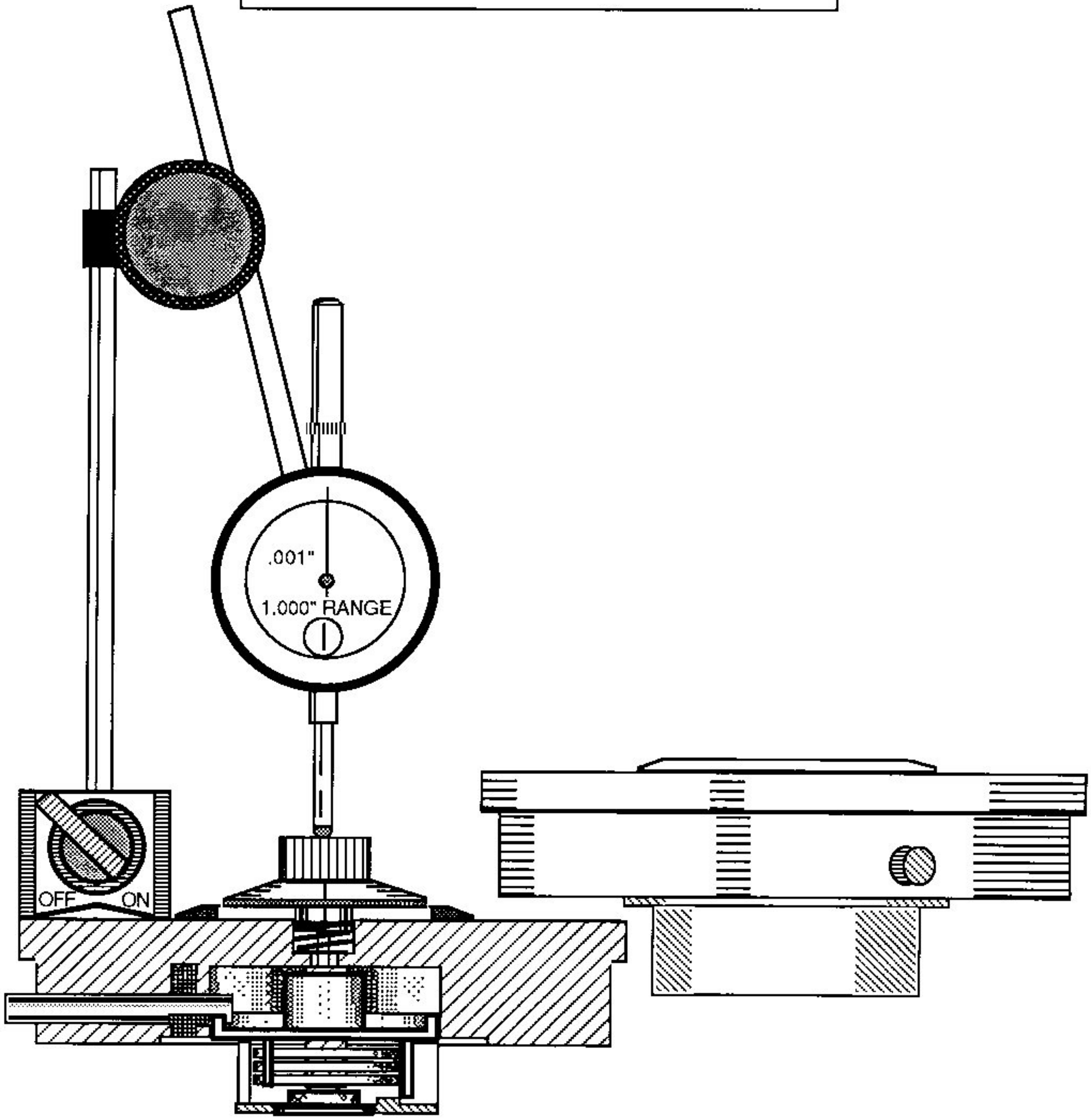
For study question answers, see page 136.

Chapter Eight

The Star Push Down Manipulation Resistant Safe

THE STAR PUSH DOWN MANIPULATION RESISTANT SAFE

Introduction to the push down lock.
A special manipulation technique is introduced.



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THE STAR PUSH DOWN MANIPULATION RESISTANT SAFE

GOALS

1. Upon completion of this chapter, you will be familiar with the lock and bolt works of the STAR manipulation resistant safe.
2. Upon completion of this chapter, you will have a working knowledge of a method of manipulating this safe, the special set-up required and what indications the lock will give during manipulation.

INTRODUCTION

This safe has a hardened steel door. Door thickness is 1 1/4" to 1 3/4" to the bolt center, depending on the rating of the safe. Independent relockers on all three bolts are set off by removal of the back cover. Though many of these safes are drilled, there is no reason to drill this safe. If the proper set-up is made, and the principle of operation clearly understood, this safe will manipulate quite readily.

PRINCIPLES OF OPERATION

Unlike previous safes discussed, the STAR push down type lock has no lever. (See fig. 8.1.) The lock fence is carried on a "fence plate," which only allows the fence to test the wheel pack when the dial is pushed down at the drop-in point. The lock does not exhibit the normal contact points that can be read on the dial or by handle movement. After the proper combination has been worked, the dial is rotated to the drop-in ("0"), pushed in and rotated right (to 73) to retract the door bolts.

In the illustration (fig. 8.1), you will see that the fence plate is free to slide on the scroll plate. The fence spring is mounted on two posts that are integral to the scroll plate. The fence spring causes the fence plate, and fence, to be spring loaded into the wheel pack. The fence plate guide and the two fence guides allow the fence plate to slide freely into or away from the wheel pack, without allowing side motion.

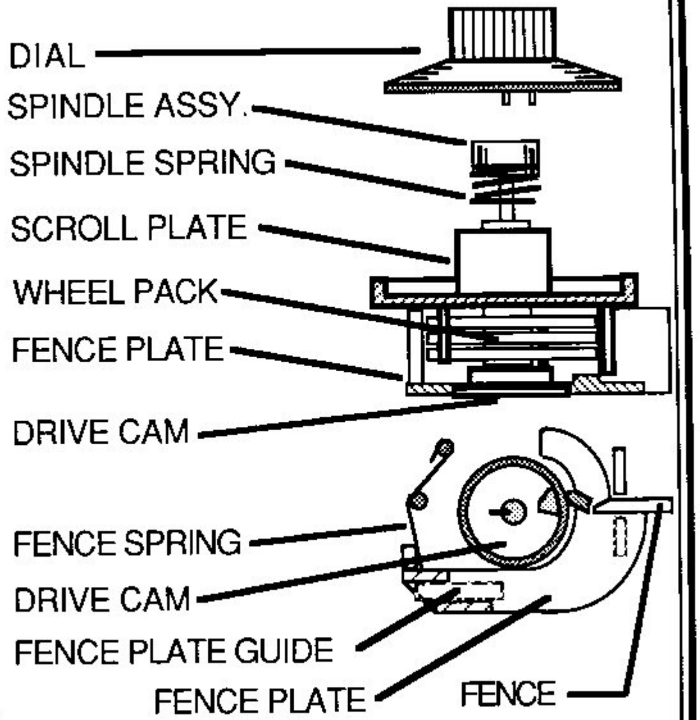


FIG. 8.1

The dial and spindle assembly are spring loaded by the spindle spring to maintain the drive cam in the up position. Figure 8.2-A, shows the lock in the locked position with the drive cam up, preventing the fence from touching the wheel pack.

The dial is prevented from being pushed down at any position but the drop-in by a raised ridge in the lock cover. (Not shown.) With the dial at "0" the spindle and drive cam are free to move down. As the dial is pushed down, against the pressure of the spindle spring, the the spindle assembly will cause the drive cam to move in a downward direction. (See fig. 8.2-B.) As the lower rim of the drive cam clears the nose of the fence plate, the fence is moved into contact with the wheel pack by the action of the fence spring. The fence "tries" the wheel pack by the action of the fence spring. If all the combination gates are present under the fence, the fence spring will cause the fence to enter the wheel pack. As the fence enters the wheel pack, the nose of the fence plate will enter the drive cam gate. Rotation of the dial to the right will cause the fence plate to bear on the fence plate guides, causing the scroll plate to rotate. Spiral grooves in the scroll plate retract the three locking bolts, allowing the safe to be opened.

Figures 8.2-A and 8.2-B illustrate the two conditions of the locking mechanism. Note that in diagram "B," the drive cam has moved down, allowing the fence to enter the wheel pack and the fence plate to move to the left. The scroll (shown in section) has retracted the door bolt. Study the diagrams to understand the action of the drive cam and fence plate.

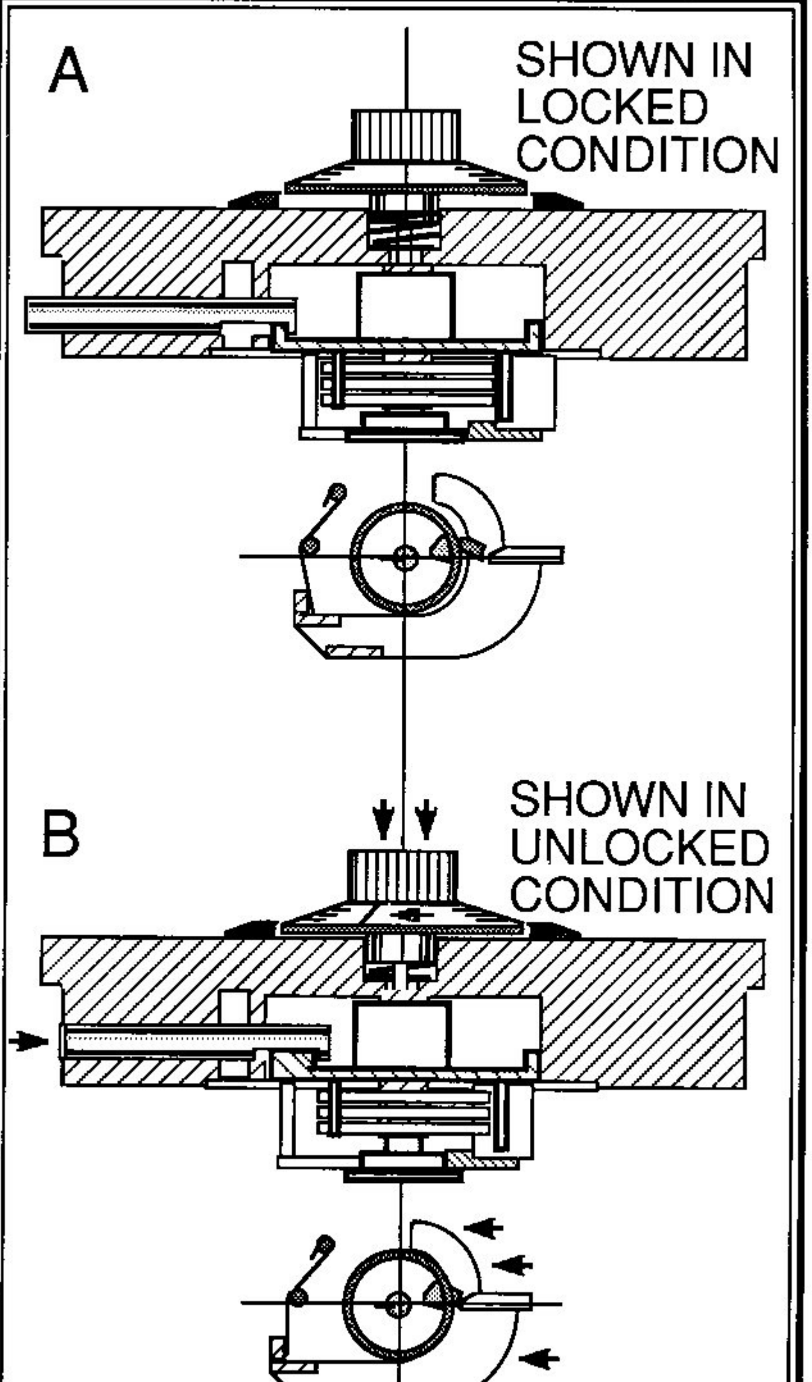


FIG. 8.2

THE LOCK

The combination wheels of this lock are S&G key change wheels. These locks may be found with LaGard key change wheels or older locks may have hand change wheels. Movable drive pins or flys are always used.

The proper action for this lock is LEFT - RIGHT - LEFT, RIGHT to the drop-in, push down and continue right to open. The dial stops, when the bolts have been retracted, at about "73."

INDICATIONS, WHERE TO LOOK

Because this lock does not exhibit contact points or readings in the normal fashion, it will be necessary to test the lock by a new method. The contact point to be tested will be found in a vertical direction. This is to say that we will test the lock by the amount of vertical motion of the dial as it is pushed down or allowed to rise up as the wheel pack is placed at different positions around the dial.

Figure 8.3, illustrations A through D, show the relative positions of the fence plate, wheel pack and drive cam of this lock during the opening sequence. Illustration "A" of figure 8.3 shows the lock in its normal position. Note that the drive cam is in the up position. The fence is held away from the wheel pack by the nose of the fence plate, which is resting on the lower rim of the drive cam.The dial can be rotated freely in this position. Note that the drive pin of the drive cam will engage the number three wheel in this position **only**.

Illustration "B" of figure 8.3 shows the drive cam in the down position. The dial must be at "0." This will allow the drive cam to bypass the ridge in the cover plate that prevents downward motion of the drive cam at any but the "0" position of the dial. Note that the action of the drive cam has allowed the fence to move to the left, where it now rests, in contact with the wheel pack.

Illustration "C" of figure 8.3 shows the drive cam in the position which will reveal the penetration of the fence into the wheel pack. This is your contact point. It is with this contact point that the lock will be manipulated.

Illustration "D" of figure 8.3 shows the fence plate at the limit of its travel. The fence has entered the wheel pack. The nose of the fence plate has entered the drive cam gate. The lock is in the proper position to retract the door bolts and allow the safe to be opened.

THE CONTACT POINT

Before we can begin taking contact readings, let's examine the action of the fence plate in the lock a little closer.

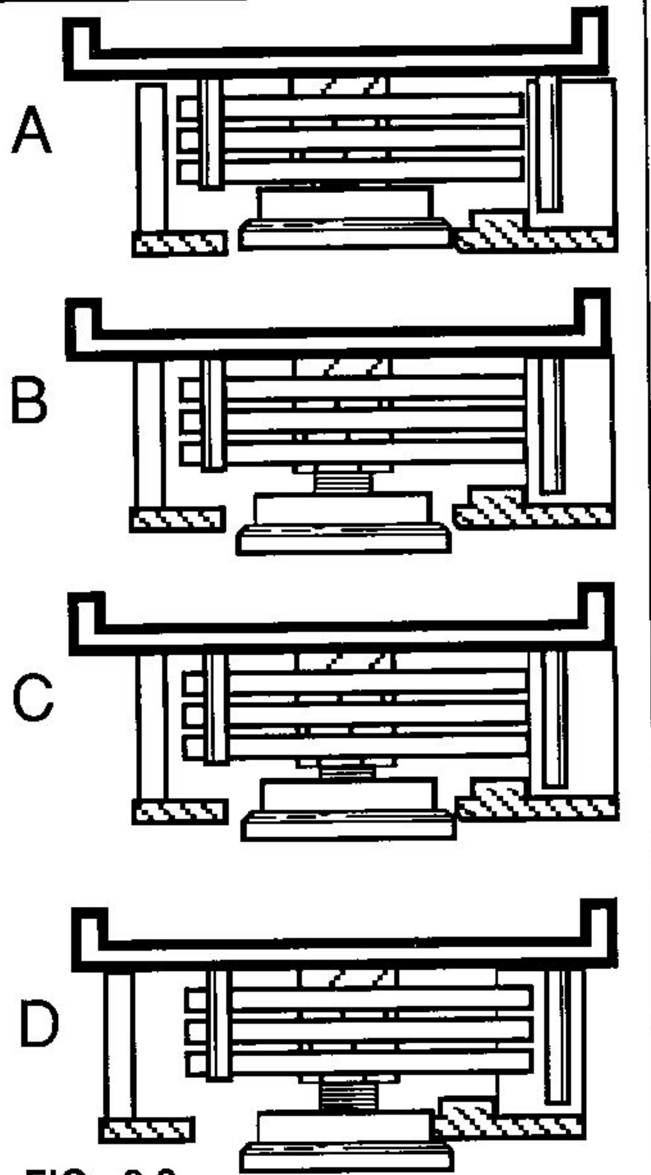


FIG. 8.3

Follow this sequence using the drawings in figure 8.3.

In figure "A," close inspection will reveal that the fence plate is not in contact with the scroll plate. Gravity and possibly the action of the fence plate spring allows the fence plate to drop down and away from the desired position. This distance is minimal, but must be allowed for in our procedure. When the drive cam is moved to position "B," friction between the drive cam and the nose of fence plate causes the drive cam plate to move away from the scroll plate. As the drive cam rises from position "B" to position "C," the drive cam will contact the fence plate nose and carry the fence plate up to make contact with the scroll plate. Further upward motion of the drive cam will cause the drive cam to force the fence plate to move to the right against pressure exerted by the fence plate spring. The desired reading is taken at the point that the fence plate is in contact with the scroll plate but before the drive cam forces the fence away from the wheel pack. This contact point is really pretty easy to feel and hear.

The explanation may make the concept a little difficult to grasp, but the contact point is very plain, due to the tension of the fence plate spring. Newer locks use a flat steel spring. The older locks used three pieces of music wire to accomplish the same tension. Anyone that has removed the cover of one of these locks has probably had the opportunity to chase these little springs. They have a tendency to fly off as the cover plate is removed.

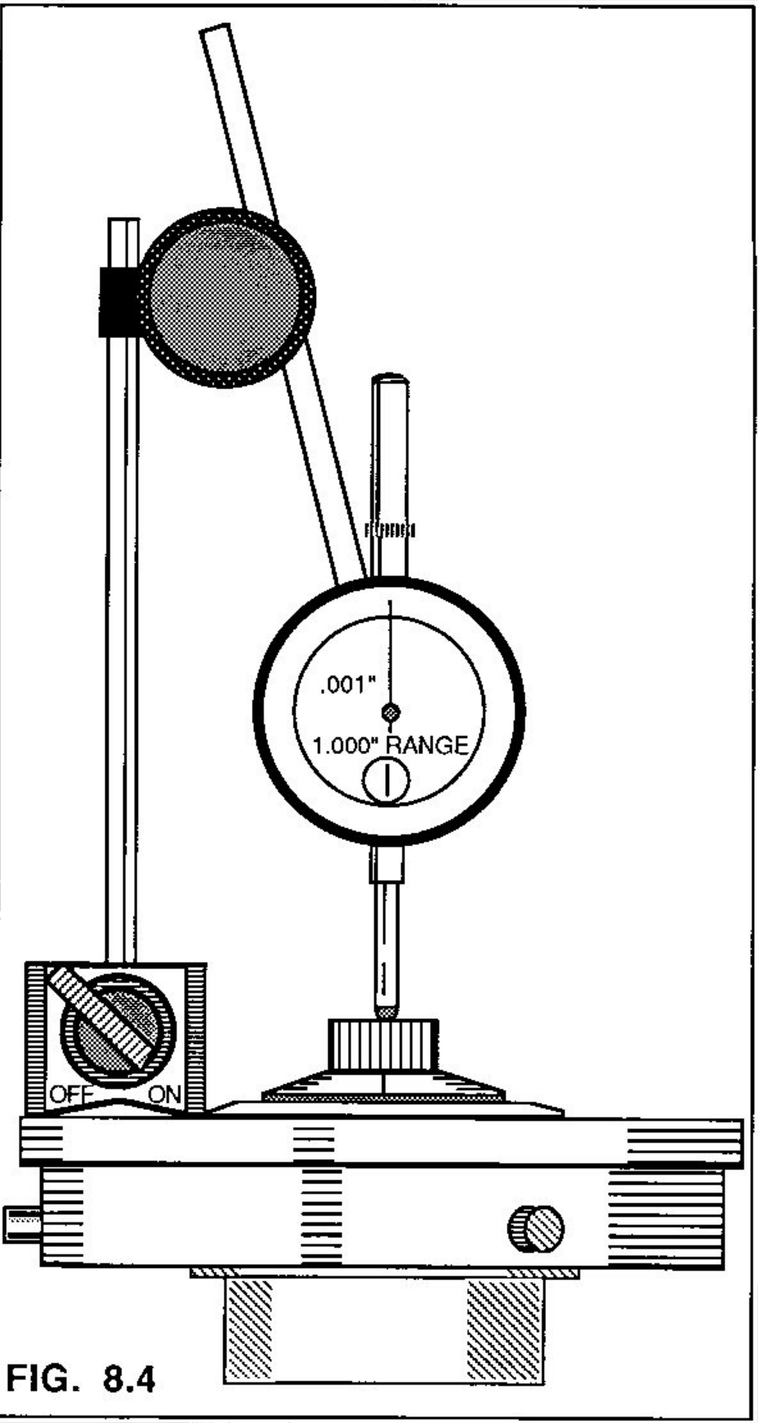


FIG. 8.4

THE INDICATOR SET-UP

To accurately measure the differences in the contact points, a dial indicator is set up as shown in figure 8.4. A magnetic base has been used here to attach the set-up to the safe head. This set-up works equally well on vertical doors. A one inch travel dial indicator calibrated in one thousandth inch increments has been chosen to test the dial travel. Dial indicators with shorter travel would not be appropriate because of the dial/spindle stroke. Total travel from the rest position to the bottom of the spindle stroke is about .150." Though it may not be absolutely essential, I prefer to find the contact point and set the indicator to zero at this point. In the manipulation at the end of this chapter, you will note that the indications were set to zero at the first contact reading. (2 1/2) After the first graph is begun, the indicator is not to be touched until the manipulation is completed. It is essential that all readings be made using the same reference. Place the point of the indicator in the center of the dial and pre-load the indication by .250." This will cause the indicator to read over the complete travel of the dial. Insure that the dial is properly seated in the spindle head. Remove any dirt or dust that might be in the holes which engage the dial pins and clean the bottom of the dial. If the spindle shaft is sticky or sluggish, clean and lubricate it to allow for free movement of the dial.

TAKING THE CONTACT READINGS

To avoid getting erratic indications, the contact readings should be taken using the following procedure. Using both hands, place the thumb and index fingers on the dial. The thumb and index fingers should be on the dial about ten numbers apart, on either side of the dial. Push down with equal pressure on both sides of the dial. The object is to move the dial straight down and straight up. Avoid flexing the spindle shaft and binding of the upper spindle shaft bearing. Remember that the lock will indicate a gate by a change in the contact point of only about .003." That is approximately the thickness of this page.

THE MANIPULATION IS BEGUN

Set up the indicator as shown and begin the manipulation as you would any other. This lock will be manipulated using a single graph format. Note that the arrows on the graph sheet, figure 8.5, have been crossed out. This graph will be run with the initial contact point at the center of the graph. Movement of the indications to the left indicate movement of the dial down. These will be good indications, or indications of a decrease in the diameter of the wheel pack. Movement of the indications to the right will indicate movement of the dial up. This will indicate an increase in the wheel pack diameter or a bad indication.

ABOUT THE EXAMPLE

The manipulation was begun with an all wheels left wheel action. (See fig. 8.5.) Because the fence floats free in the lock, this lock will have a tendency to mark on the number one or number three wheel in the first graph.

The graph indicates an area of best indication between 55 and 75.(See inset, fig. 8.5.) Amplification of this area reveals a gate at 65. The amplification also reveals a low spot and suspected gate at 59.

A table of test combinations (fig. 8.6) revealed the gate at 65 to be on wheel number one.

A second set of test combinations (fig. 8.7) was run on the number 59. This revealed that wheel number three was the marking wheel. Graph number one gave us two gates.

A second graph was run (fig. 8.8) using the information gained in the previous steps. The safe was opened during the second graphing procedure. The good indication was .003." The time was under two hours.

This manipulation was performed on a new safe, so that any wear in the lock would not be a consideration in the indications. The graphs and trial combination results are completely factual and accurate.

Though many of these safes are drilled, I can see no reason why manipulation is not a profitable method of opening this lock.

COMBINATION LOCK GRAPH NO. 1 WHEEL ACTION 1 AWL
LOCK MANUFACTURER STAR (PUSH DOWN) 2
DATE 8-23-87 REMARKS 3

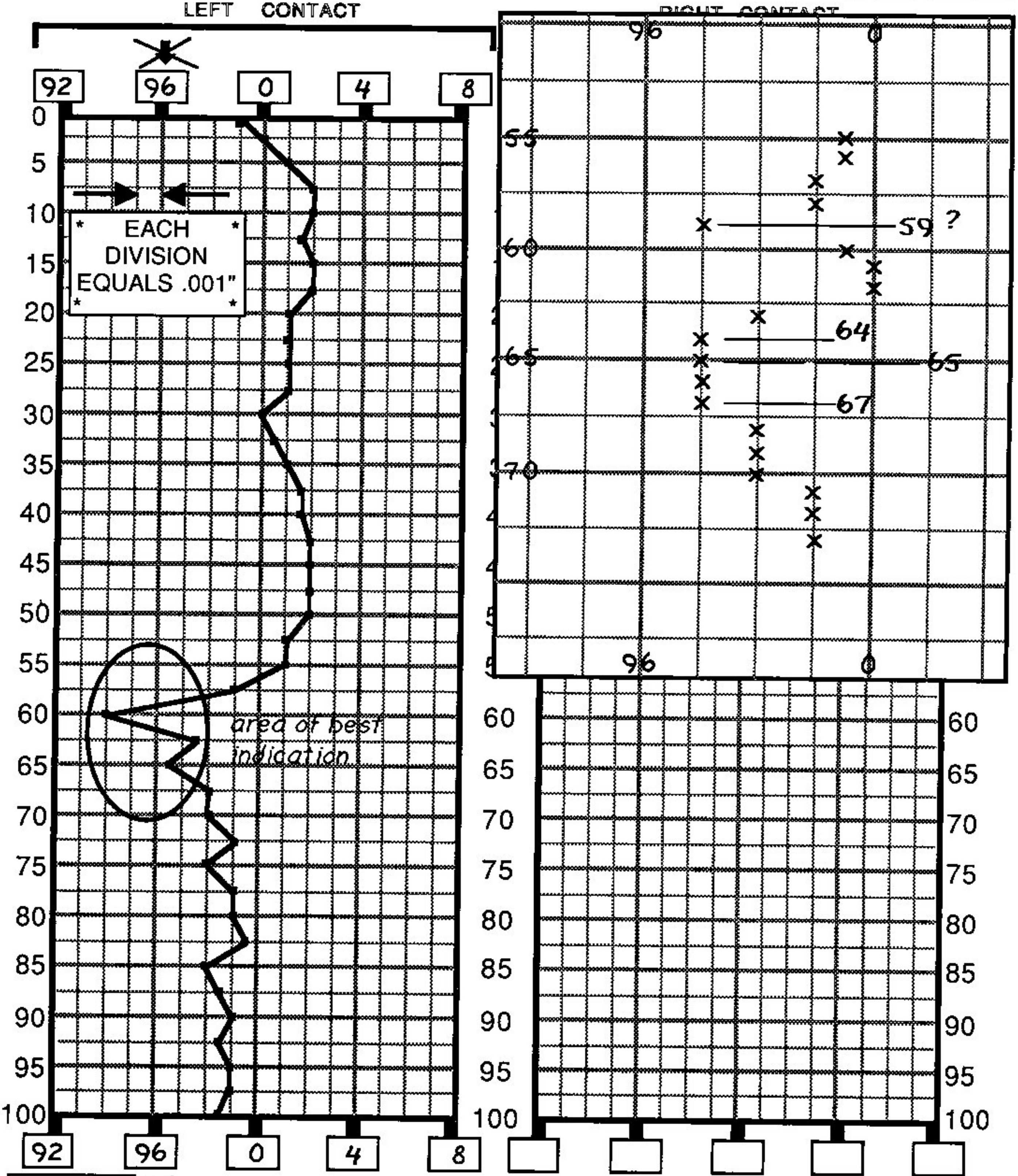


FIG. 8.5

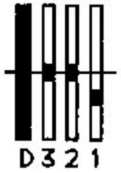
(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

FIG. 8.6

wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	75	65	65			98
2	65	75	65			94
3	65	65	75			94

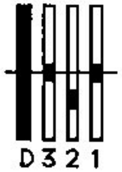
TEST COMBINATIONS

①



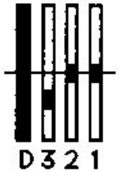
Turn right 4 times to 75
Turn left 3 times to 65
Turn ____ 2 times to ____
Turn right to contact area,
read contact points.

②



Turn left 4 times to 65
Turn right 3 times to 75
Turn left 2 times to 65
Turn right to contact area,
read contact points.

③



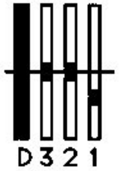
Turn left 4 times to 65
Turn ____ 3 times to ____
Turn right 2 times to 75
Turn left to contact area,
read contact points.

GATE CENTER left 65
HIGH TEST NUMBER 75
LOW TEST NUMBER 55

wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
1	55	65	65			98
2	65	55	65			96 1/2
3	65	65	55			96 1/2

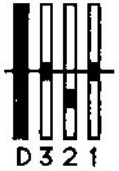
TEST COMBINATIONS

①



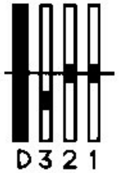
Turn right 4 times to 55
Turn left 3 times to 65
Turn ____ 2 times to ____
Turn right to contact area,
read contact points.

②



Turn left 4 times to 65
Turn right 3 times to 55
Turn left 2 times to 65
Turn right to contact area,
read contact points.

③



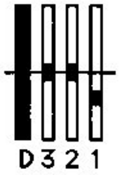
Turn left 4 times to 65
Turn ____ 3 times to ____
Turn right 2 times to 55
Turn left to contact area,
read contact points.

CONCLUDE *Wheel #1 set to Left – 65*

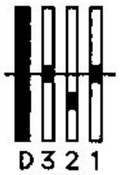
FIG. 8.7

wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
~~1~~						
2	65	69	59			96
3	65	59	69			96 1/2

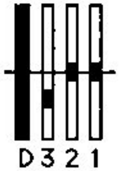
TEST COMBINATIONS



① ~~Turn ____ 4 times to ____~~
~~Turn ____ 3 times to ____~~
~~Turn ____ 2 times to ____~~
~~Turn ____ to contact area,~~
~~read contact points.~~



②
Turn *left* 4 times to 65
Turn *right* 3 times to 69
Turn *left* 2 times to 59
Turn *right* to contact area,
read contact points.

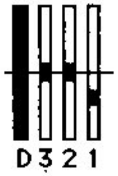


③
Turn *left* 4 times to 65
Turn *right* 3 times to 59
Turn *left* 2 times to 69
Turn *right* to contact area,
read contact points.

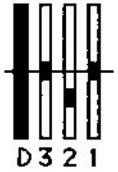
GATE CENTER *left 59*
HIGH TEST NUMBER 69
LOW TEST NUMBER 49

wheel tested	WHEEL #1 AT	WHEEL #2 AT	WHEEL #3 AT	LEFT CONTACT POINT	RIGHT CONTACT POINT	CONTACT AREA
~~1~~						
2	65	49	59			93 1/2
3	65	59	49			96 1/2

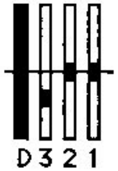
TEST COMBINATIONS



① ~~Turn ____ 4 times to ____~~
~~Turn ____ 3 times to ____~~
~~Turn ____ 2 times to ____~~
~~Turn ____ to contact area,~~
~~read contact points.~~



②
Turn *left* 4 times to 65
Turn *right* 3 times to 49
Turn *left* 2 times to 59
Turn *right* to contact area,
read contact points.



③
Turn *left* 4 times to 65
Turn *right* 3 times to 59
Turn *left* 2 times to 49
Turn *right* to contact area,
read contact points.

CONCLUDE *Wheel #3 set to left-59*

COMBINATION LOCK GRAPH NO. 2 WHEEL ACTION

1 @ L - 65
2 AR from 65
3 @ L - 59

LOCK MANUFACTURER STAR (PUSH DOWN)
DATE 8-23-87 REMARKS right 82 1/2 on wheel #2

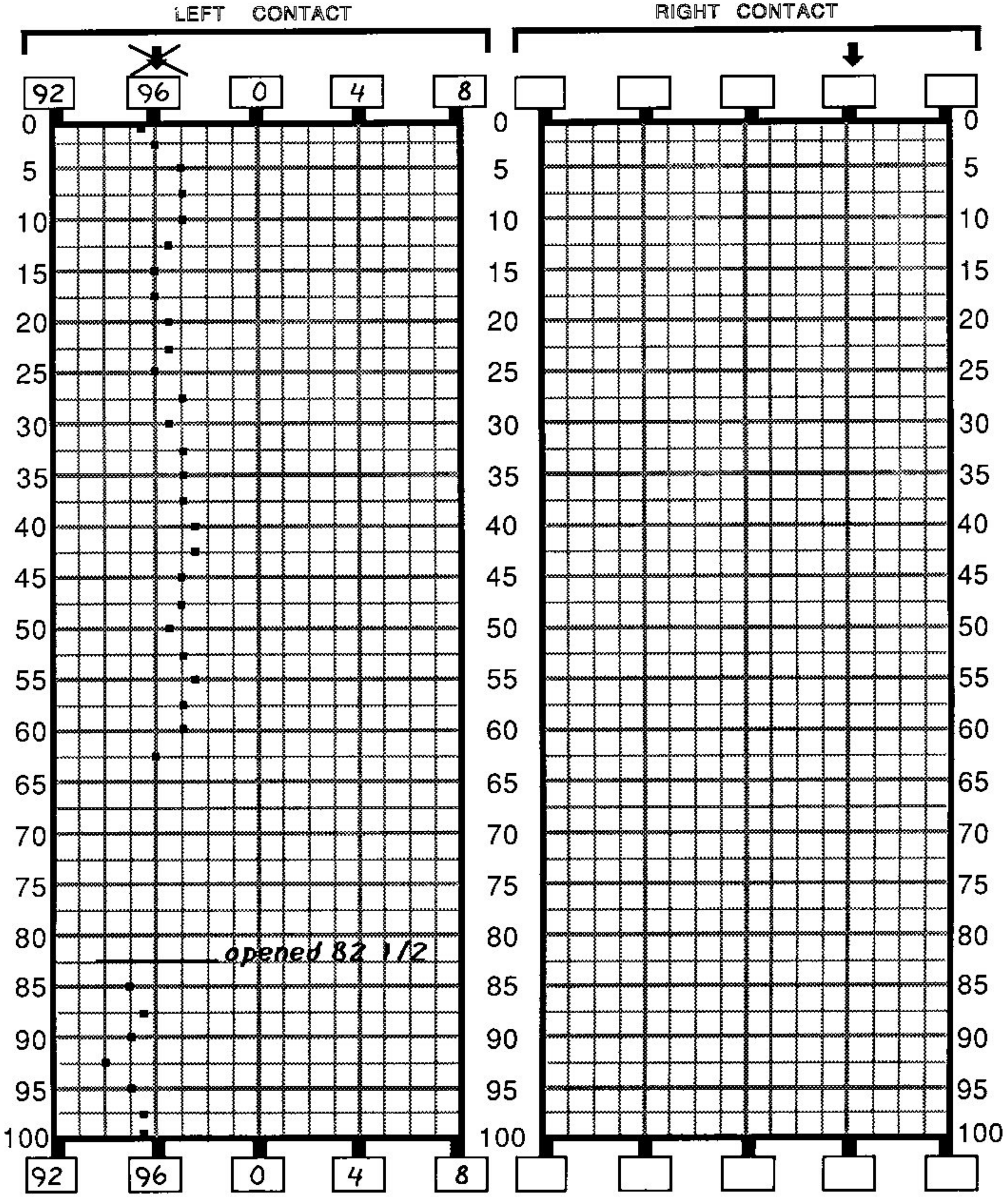


FIG. 8.8

(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

STUDY QUESTIONS

The following questions and exercises are designed to test your understanding of the material covered and reinforce some of the more important points. These questions are to stimulate thought and increase your understanding of the concepts and ideas presented. Study them carefully.

1. The driver (spindle and drive cam) are spring loaded in the raised position.

A. What prevents the driver from being pushed down at any position but the drop-in point, ")" on the dial?

B. What causes the fence to "try" the wheel pack as the dial is pushed down?

2. The fence plate guides insure that the fence "tries" the wheel pack at the proper point. They also serve to transmit rotary motion to the ______________, which retracts the door bolts.

3. In figure 8.3 (page 97), which illustration describes the position of the drive cam and fence plate where contact points are to be taken? (A,B,C or D)

4. Why is it necessary to use a dial indicator to manipulate this type of safe?

5. The proper wheel action for this lock is; Left- Right- Left, Right to "0", push down and turn right to stop. Wheel number one or wheel number three will usually indicate first. What would be the best direction to begin the manipulation?

a. all wheels right
b. all wheels left

6. What is the unit of measure in the horizontal axis of the graph sheet used to manipulate this type of lock?

7. As a gate passes under the fence of this lock, the contact point will give an indication by;

a. moving down (indication changes toward the left side of the graph)
b. moving up (indication changes toward the right side of the graph)

indicator / graph movement
95 - 96 - 97 - 98 - 99 - 0 - 1 - 2 - 3 - 4 - 5 - 6 - 7
⬅ left - right ➡
dial movement down - up

For study question answers, see page 137.

Chapter Nine

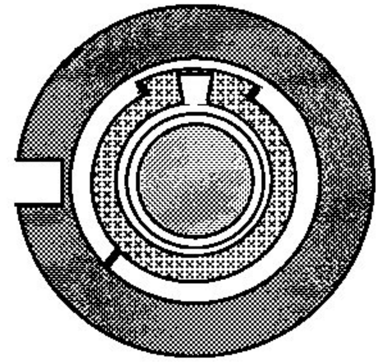
Parking, Manipulation of a Mosler 302

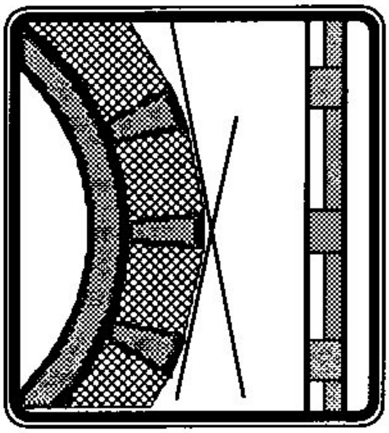
PARKING
MANIPULATION OF A MOSLER 302

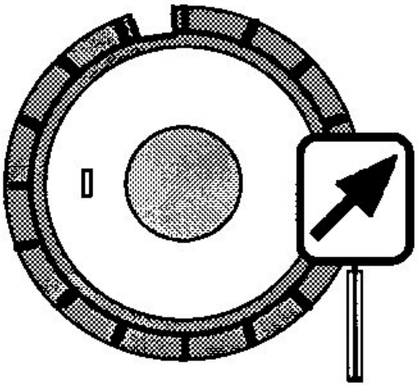
The concept of parking is introduced. False gates are revealed as an aid to manipulation.

The only way
to fail, is to
quit trying

RGS







WHAT-IF ?

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PARKING

GOALS

1. Upon completion of this chapter, you will be familiar with the technique and reasoning behind parking the wheel pack.
2. Upon completion of this chapter, you will have gained a new perspective on the "false gate."

WHAT IS PARKING ?

When we refer to parking, we mean that a particular wheel or group of wheels is set to a known position while another wheel is being moved. In previous manipulations, we parked wheels at their known gates as the other wheels in the lock were being rotated and graphed. There are some special cases that will require that the wheel pack be parked at a position that will not necessarily be a known gate.

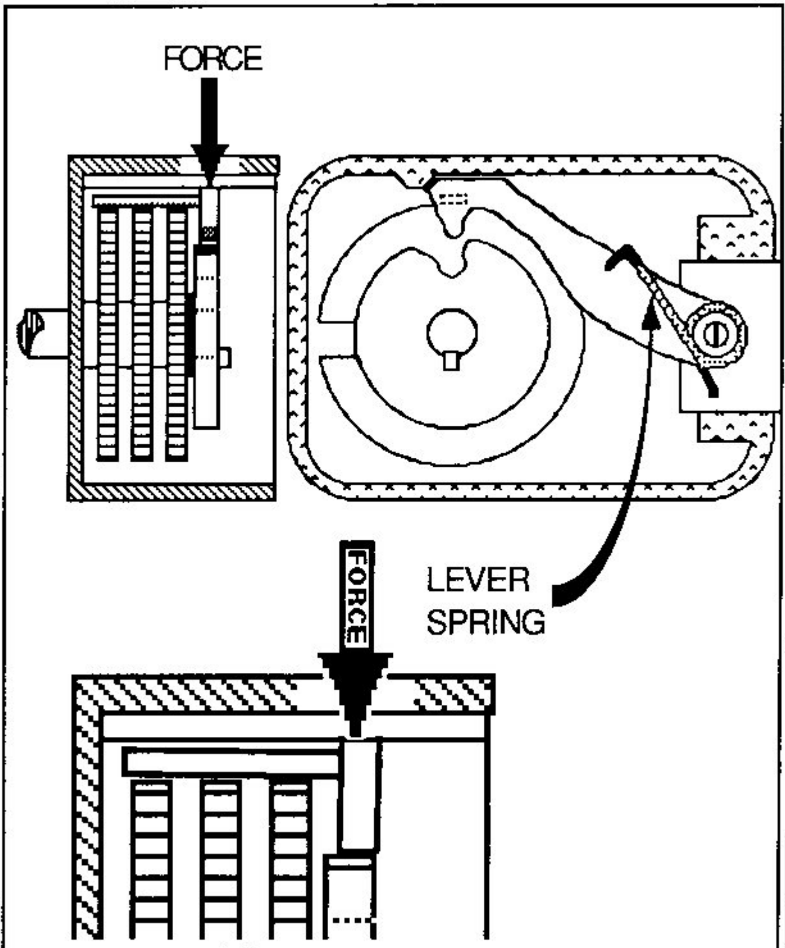
WHY IS PARKING NECESSARY ?

There will be manipulations that will begin with a graph that yields no defined gate indication. The graph will indicate minimal variation in the wheel pack or, as in the case of the MOSLER 302 & 402 locks, such a variation in the indications that finding a gate from the indications is impossible. By parking two wheels and running a graph of the third (for a three wheel lock) we will be able to gain usable information that will lead us to the discovery of a gate position. When graphing of a single wheel, it is not necessary to use trial combinations to prove the wheel. If the dialing sequence is correct and the other wheels have not been disturbed, the gate found will be on the wheel being graphed.

ABOUT THE LOCK

As we manipulate, knowledge of the construction of the lock will assist us in choosing a course of action.

If we are manipulating a lever fence type lock, we know that a majority of these locks will indicate on wheel number three first. Figure 9.1 shows the major cause for this. As you can see, the fence/lever spring must place downward force on the lever to cause the fence to "try" the wheel pack. Because of tolerances between the lever screw and lever, this downward force will also cause the lever to tip or warp as the fence touches the wheel



cause of fence warpage

Fig. 9.1

pack. Because of this tipping or warp, the number three wheel will in most cases be the wheel to give first indication. Though the illustration shows the drive cam to the rear of the lock, this principle applies equally to locks with the drive cam to the front. I do not mean to overstate this fence warp. It only accounts for a few thousandths of an inch in the movement of the nose of the lever into the drive cam gate. When added to the indication the gate must give as it passes under the fence, it will allow the manipulator to better see or understand the reasoning behind why wheel number three indicates first in a majority of cases. A graph of wheel number three, when the wheel pack is not giving good indications, will usually reveal a gate.

WHEN TO PARK

There are two primary reasons to park. The first is when the wheel pack is not indicating. The second is when the wheel pack is giving such wide and confusing indications that finding a gate is impossible.

When the first graph of the wheel pack (all three wheels) gives no definite gate indications, it is possible that the gates are being masked by high spots in adjacent wheels. The graph of three wheels together is showing a composite indication. There is no way to divide the indications except by graphing one wheel at a time. By parking wheels one and two in an area shown to be relatively low in the first graph, it is possible to run a graph of wheel three only, to find a gate indication. To gain meaningful information from the graph, test only one wheel at a time. If the graph shows a low "area" that is better than previous indications, find its center and use it as you would a gate in the next graph.

If the graph of wheel number three does not result in the location of a gate, return wheel number three to the low area and graph wheel number two. Hold wheels one and three at their chosen low areas. Graph wheel number one last.

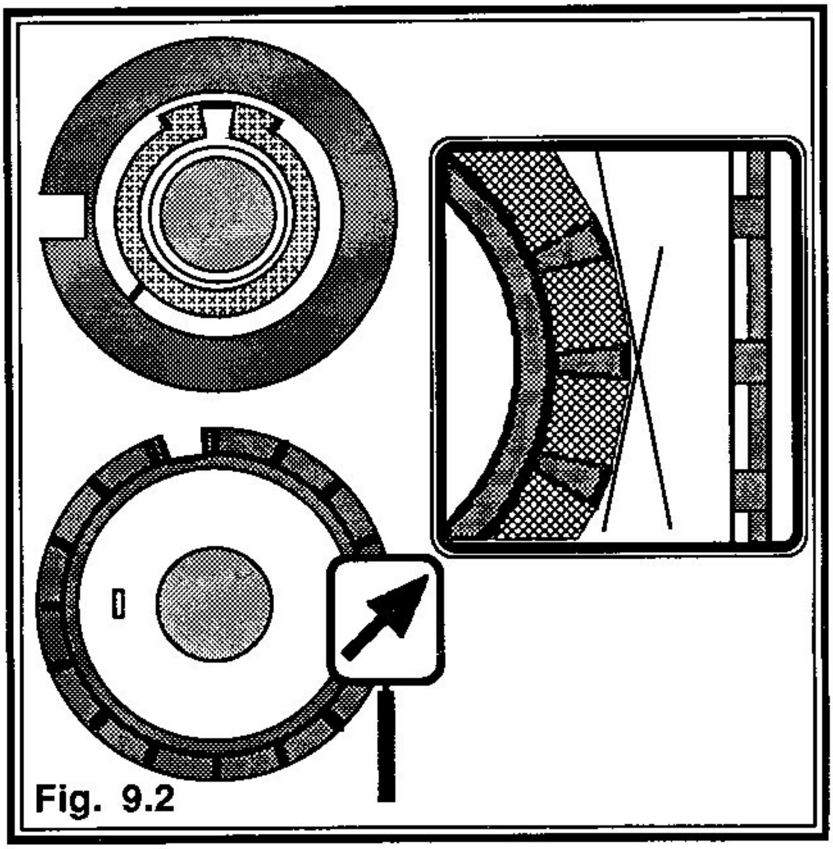


Fig. 9.2

The second case requiring the wheels to be parked and graphed independently is the presence of indications that are so confusing that they cannot be interpreted. Though another lock manufacturer may use this same idea, the MOSLER 302 and 402 series locks are the most common. (See fig. 9.2.) At first glance, the Mosler wheel looks like any other hand change combination wheel. On closer examination we find that what appeared to be a round wheel is actually a 32-sided wheel. The circumference of the wheel is divided into 16 major flat sides that are the same width as the gate and 16 minor flat sides that form bridges for the false gates. The wheel was designed originally to resist x-ray attempts. If the wheel was x-rayed, it would appear as a wheel with sixteen gates. Out of this design grew the idea of creating sixteen false gates in each wheel, to resist manipulation attempts also. This confusion tactic works, but with only limited success. If handled properly, this lock should manipulate like any other.

One technique that has given good success in manipulating these locks is as follows.

1. Set up and run a graph of the wheel pack in an all wheels right evolution, every 2 1/2 numbers.
2. In the graph there should be at least one indication that suggests a low spot in the wheel pack. Choose this as the area of best indication.
3. Run a short graph from ten numbers above to ten numbers below the area of best indication on wheel number three only. Hold wheels two and one at the center of the area of best indication. From the amplification of this area, find the GATE CENTER. Whether this GATE CENTER is true or false will have no effect on the manipulation.
4. Using information gained in steps two and three, run a short graph of wheel number two from ten numbers above to ten numbers below the the area of best indication. Hold (park) wheel three at its GATE CENTER, and wheel number one at the center of the area of best indication. Determine the GATE CENTER for wheel number two. Again, it makes no difference whether the gate is a false gate or not. (Remember that "GATE CENTER" in these steps refers to a TRIAL or TEST GATE.)
5. Using information gained in steps three and four, Run the same short graphing procedure on wheel number one. Hold wheels two and three at their "TEST GATE CENTER" positions.

In this first step of the manipulation, you will have improved the contact area by at least a whole number. All three wheels are now placed with a gate under the fence. The gates may all be false gates but, in the following steps, if the fence finds a true gate, it will not be held high by a ridge between the false gates.

6. **PARK** wheels one and two at their TEST GATE CENTER positions and run a complete graphing sequence on wheel number three. A gate should be clearly defined.
7. PARK wheel number one at its TEST GATE CENTER position and wheel number three at its new GATE CENTER. Run a complete graphing sequence on wheel number two. A gate should be found.
8. Park wheels three and two at their gate centers. Graph wheel number one to find the remaining gate.

Seven out of ten MOSLER locks will be opened using this procedure. If the lock remains locked, assume that one of the gates found is a false gate. Hold or **PARK** two wheels, and run a graph on the third. Only your indications will tell which wheel is the most likely false indication.

AN ACTUAL MANIPULATION

The following manipulation was chosen because of the problems encountered. The "what-if" scenario will illustrate the steps *necessary when the first gate indications fail to open the lock. (This procedure is common to all manipulations.) A new graphing procedure is introduced, specific to the Mosler lock. Parking is used in all but the first graph.*

Before we begin the manipulation, let's more closely examine the Mosler wheel pictured earlier in the chapter.

As in all cases, specific knowledge of the locking mechanism will lead us to a special method of handling the manipulation. We know that the manufacturer has placed false gates around the combination wheels to confuse the manipulator. These false gates, **stumbling blocks** to the novice, will be revealed **as stepping stones** for the master manipulator.

If we know that the combination wheel is divided in such a way as to allow for the placement of exactly sixteen gates around its circumference, we must say that there are only sixteen possible locations that can be gates in the wheel. By locating one wheel gate, either a false or a true gate, we know the positions for all the gates of that wheel. With this knowledge we can graph a whole wheel by making only sixteen contact readings. When compared to the usual forty contact readings necessary to accurately graph a normal combination wheel, we find the Mosler easier to manipulate than a lock without false gates. The false gate is an aid to manipulation that allows the manipulator to graph a wheel in one third the time normally required.

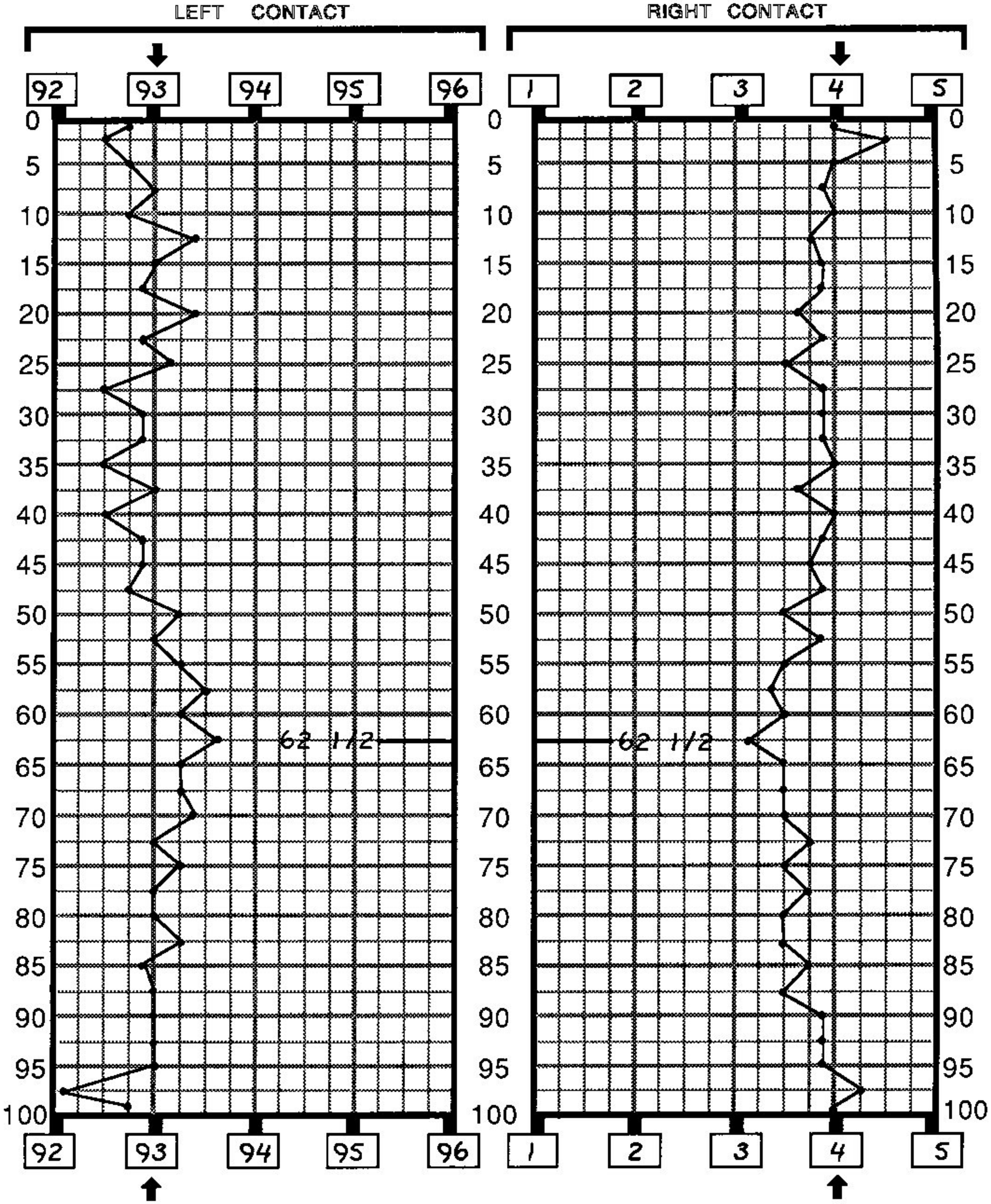
By equally dividing a one hundred number wheel into sixteen parts, we find the gates to be six and one quarter (6 1/4) numbers apart. (100 ÷ 16 = 6.25) If we find a gate at "56" on the dial, we know that gates will exist at "62 1/4," "68 1/2," "74 3/4,"...etc. around the dial until we return to "56" again.

The manipulation is begun in the normal manner. We find that we have a spring fence lock with three wheels. The contact points are at "4" and "93."

GRAPH NUMBER 1

A graph of the wheel pack is run every two and one half numbers around the dial. The resulting graph (see fig. 9.3) reveals the lock to be a Mosler manipulation resistant type. At this point, the manipulation will take a new turn. A point on the graph must be chosen as a park point for the wheels. The best indication, "62 1/2," is chosen as the park point for the wheels.

COMBINATION LOCK GRAPH NO. 1 WHEEL ACTION 1 AWL
LOCK MANUFACTURER Mosler 2
DATE REMARKS 3



(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

FIGURE 9.3 Erratic contact points, indicating false gates in the combination wheels.

GRAPH NUMBER 1A

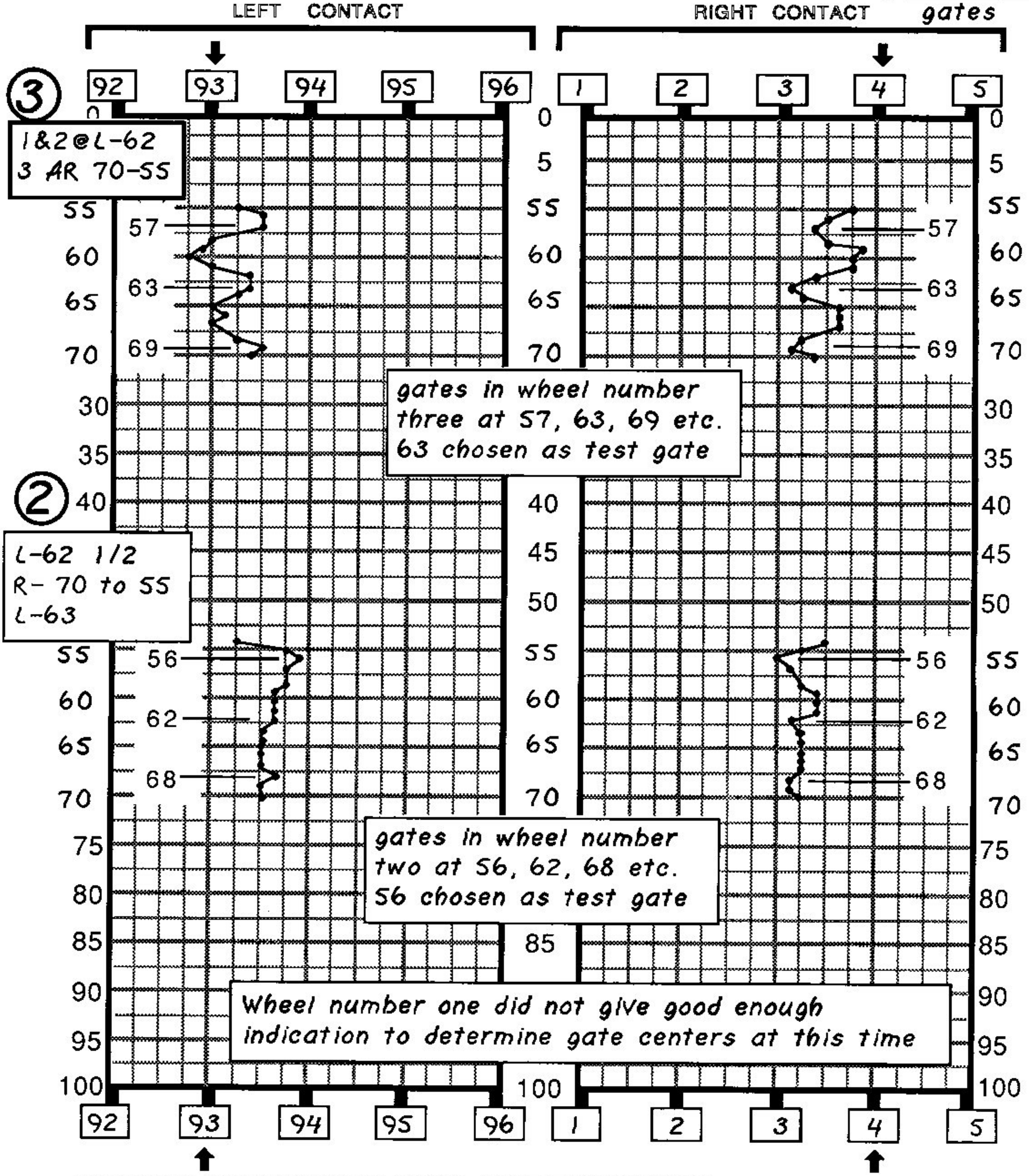
Graph sheet "1A" is begun as shown in figure 9.4. The first short graph is of wheel "3". The legend to the left shows the wheel being tested (3) and the wheel positions (1&2 @ L-62, 3 Around Right, every number, from 70 to 55). The resulting graph shows the positions of the gates in wheel number three to be at 57, 63 and 69. By locating at least three gates, we can be fairly positive that our readings are accurate. The gates will be exactly six numbers apart. Re-check the contact points if your readings are different. **The gates are exactly six numbers apart.** A second short graphing sequence is run to determine the positions of the gates in wheel number two. The information gained in the above step is used to position wheel number three. Any of the three gates could have been used ("63" was chosen). Wheel number one is held at "62 1/2" and wheel number three is parked at "63" as wheel number two is graphed from 54 to 70, every number. The resulting graph indicates gates at 56, 62 and 68. The graph also shows the effect of moving away from the drive cam. As we move away from the drive cam, our indications will become progressively less distinct. The wheel closest to the drive cam gave sharp indications of the wheel gates. As we move away from the drive cam to wheel number two our indications become less distinct. Fence warp would explain this loss of definition in our indications. The fence is not resting squarely on the wheel pack, which would make wheel number three indicate first and better than the other wheels.

A short graph was run on wheel number one using information gained in the two preceding graphs, but the indications were not good enough to see the wheel gates.

COMBINATION LOCK GRAPH NO. 1 A WHEEL ACTION 1 test all

LOCK MANUFACTURER Mosler test gate wheel 2, 56 2 wheels

DATE ________ REMARKS test gate wheel 3, 63 3 find test gates



1&2@L-62
3 AR 70-55

L-62 1/2
R- 70 to 55
L-63

gates in wheel number three at 57, 63, 69 etc. 63 chosen as test gate

gates in wheel number two at 56, 62, 68 etc. 56 chosen as test gate

Wheel number one did not give good enough indication to determine gate centers at this time

(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

FIGURE 9.4 Finding the false gate centers in wheels three and two.

GRAPH NUMBER 2

Graph number two is begun, (fig. 9.5) using information gained in graphs 1 and 1A. Wheel number one was placed or parked at left 62 1/2 and wheel number two was placed at right 56. Wheel number three was graphed around left every six and one quarter numbers. Contact readings of wheel number three were only taken at the known gate positions.

NOTE:

By knowing the positions of three of the gates in wheel number three, it was possible to project all other gate positions.

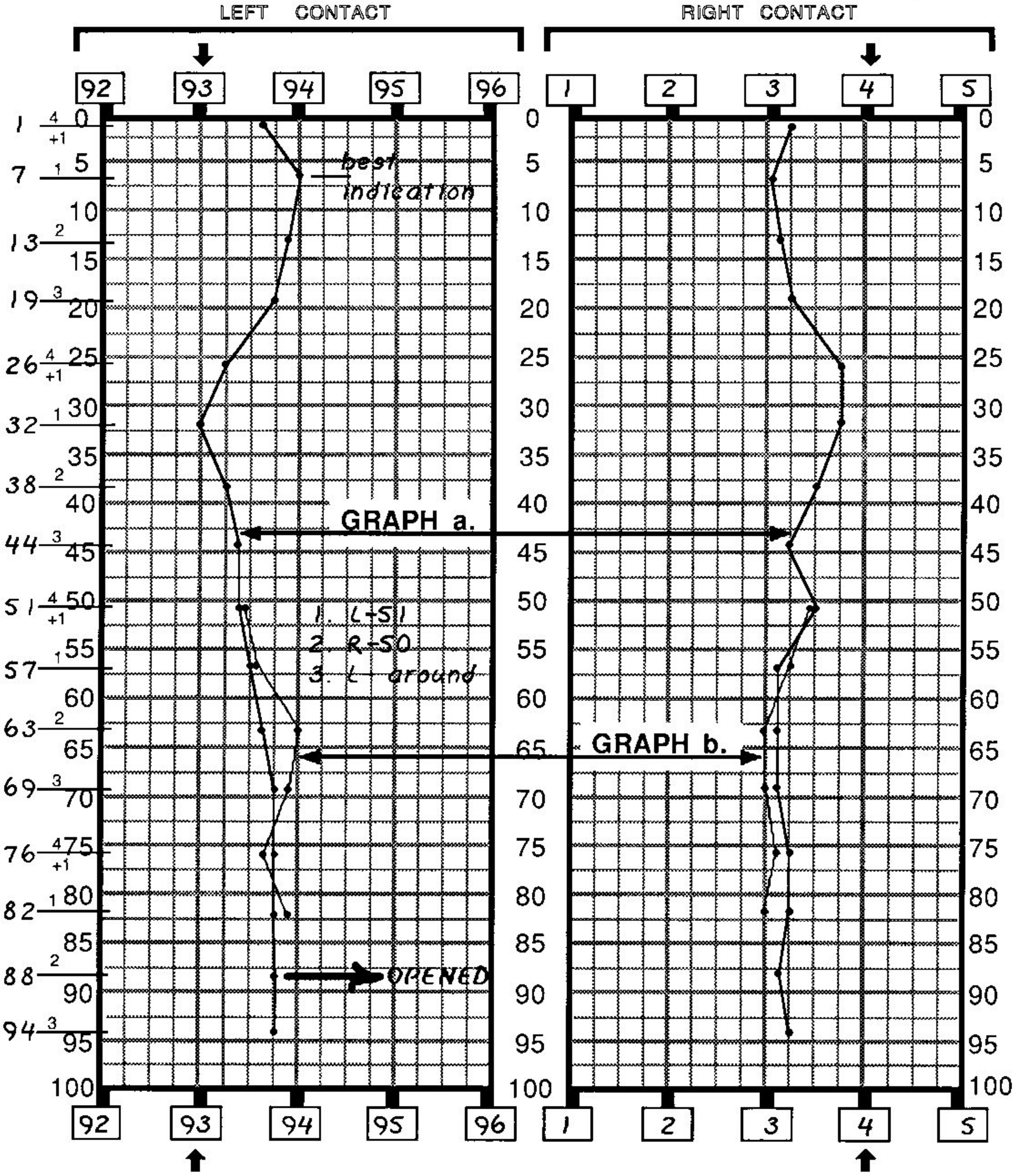
Along the left margin of the graph sheet you will notice that all sixteen gates have been penciled in. Because dialing to quarter numbers would cause undue confusion in the dialing procedure, only whole numbers were used to locate the wheel gates. Note that each gate is numbered from one to four. Every fourth number is advanced an extra number. This catches up the wheel to make up for the quarter number dropped with each advance of the dial. Count one, two, three, four plus one. If the quarter numbers are not counted, the gate will drift away from the fence location with each advance of the dial, causing the contact readings to be of no value after the fifth projected gate.

The best indication was found to be at "7". The conclusion that wheel number three was set to "7" was entered in the remarks block of the graph sheet.

Disregard the second graph (b) on this sheet for now.

COMBINATION LOCK GRAPH NO. 2 WHEEL ACTION
LOCK MANUFACTURER Mosler
DATE ______ REMARKS wheel #3 set to 7

1 left 62 1/2
2 right 56
3 around left



(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

FIGURE 9.5 a. **Wheel three is graphed around left every 6 1/4 numbers.**
b. **The safe is opened at 88 during graph no. 6.**

GRAPH NUMBER 3

Graph number three is begun, using the information gained in the previous graphs. Wheel number one was parked at "left 62 1/2" and wheel number three was parked at "left 7". Using information gained in graph 1A-2, the gate locations were projected around the wheel and penciled into the left margin of the graph sheet. Contact readings were taken at all possible gate locations and a conclusion was drawn that 75 gave the best indication in the graph. Because the indications were not sharply defined, the conclusion was to use 75 as a trial gate.

Disregard the second graph (b) on this sheet for now.

COMBINATION LOCK GRAPH NO. 3 WHEEL ACTION

LOCK MANUFACTURER Mosler

DATE ______ **REMARKS** 75 trial gate, not conclusive

1 left 62 1/2
2 around right
3 left 7

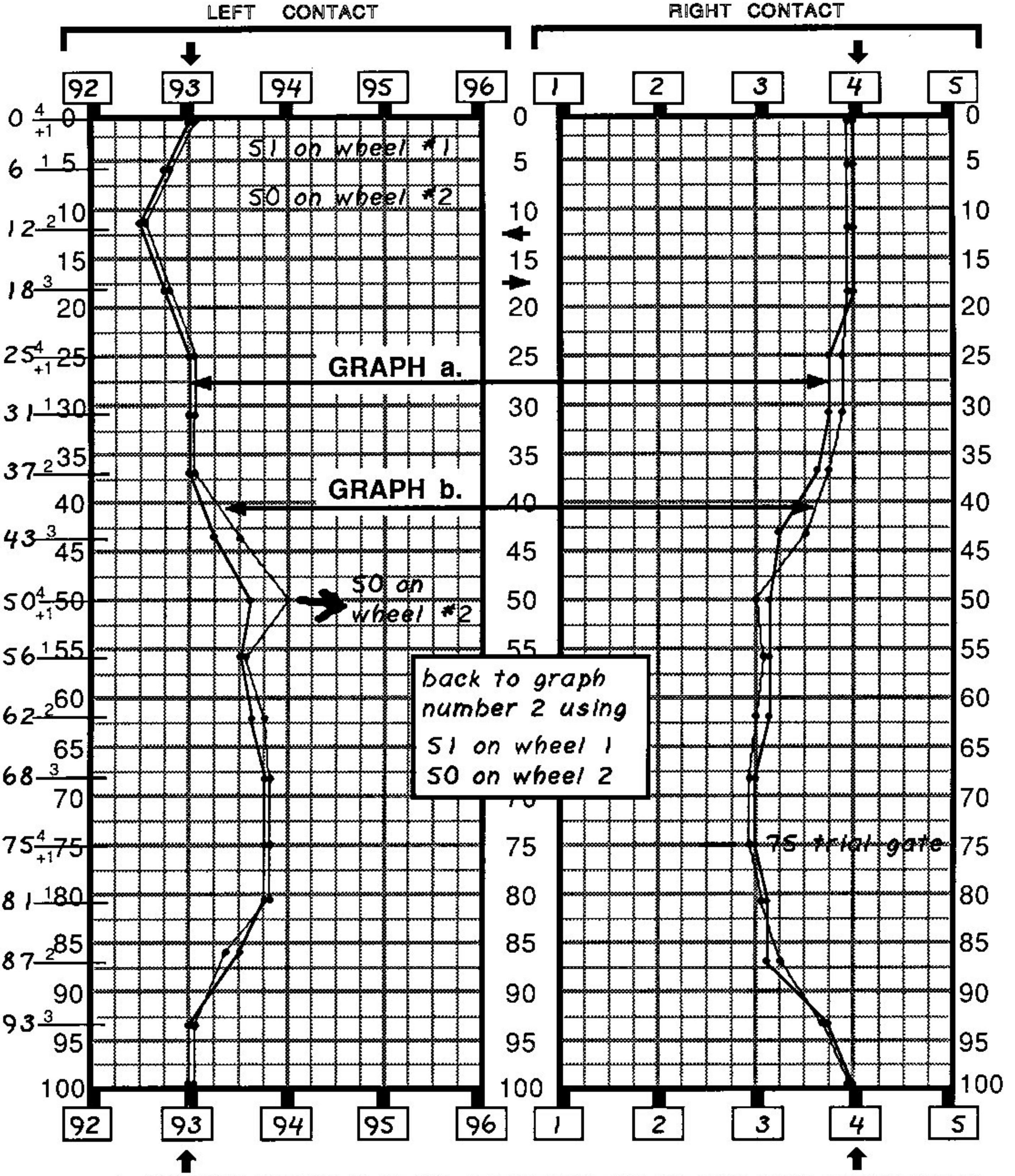


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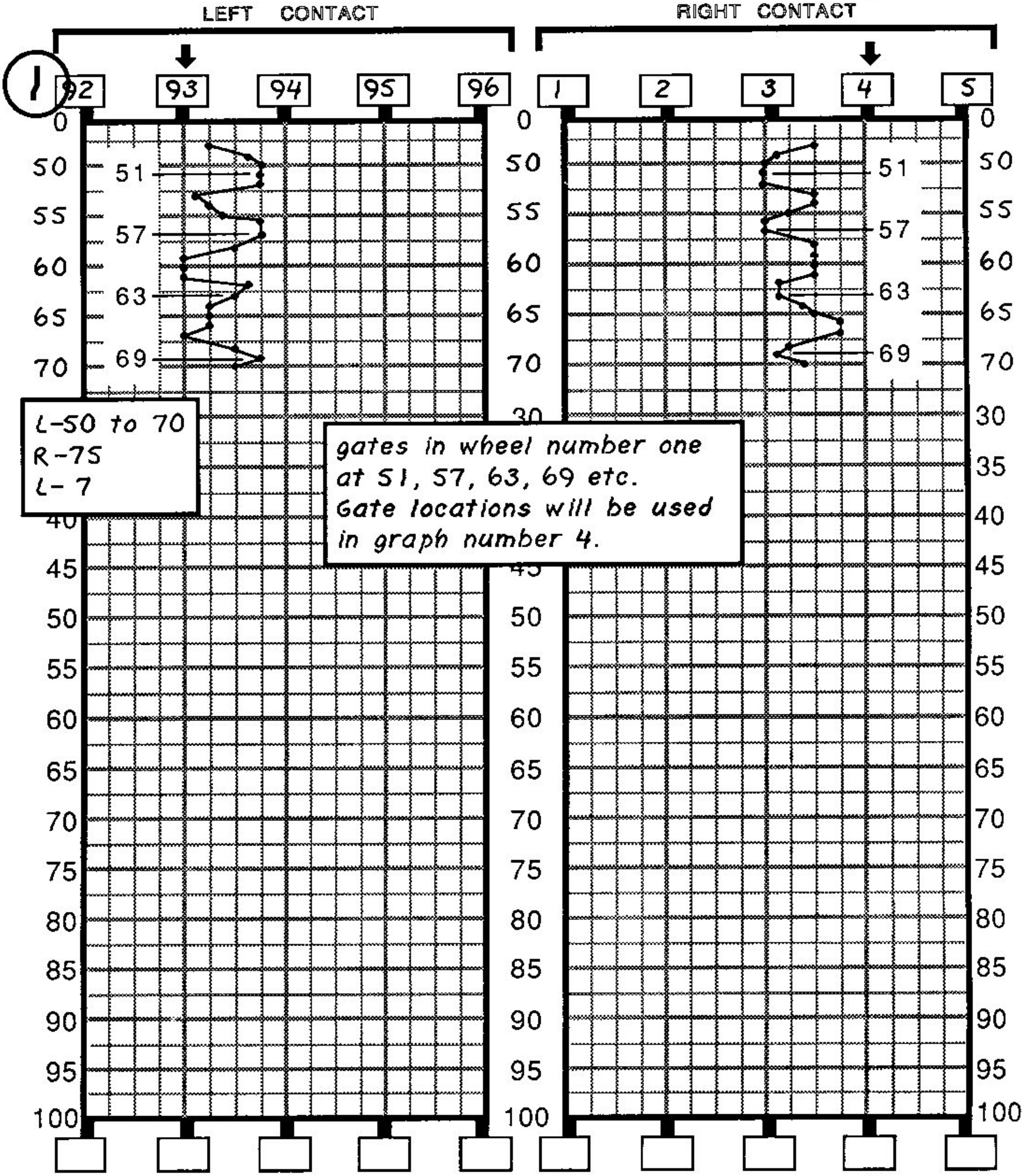
FIGURE 9.6 a. Wheel number two is graphed around right every 6 1/4 numbers.
b. Wheel number two is regraphed(graph #5), revealing a gate at 50.

GRAPH NUMBER 3 A

Before we can begin the graph of wheel number one, it will be necessary to locate the gates. (See fig. 9.7.) A short graph of the area of best indication will reveal the gate locations in wheel number one and allow us to project the gates around the wheel. Wheels two and three were parked at their "TEST GATE" positions, as determined in previous graphs. The graph was run on wheel number one, every number from 50 to 70. Because of the contact readings at 50, 51 and 52, additional contact readings were taken at 48 and 49. These contact readings allowed the gate indication to be completed for the gate at 51. Gate positions for wheel number one were found at 51, 57, 63 and 69.

Note how sharp the indications are. With wheels two and three at their best indicating gate position, the fence was allowed to accurately follow the shape of wheel number one.

COMBINATION LOCK GRAPH NO. 3A WHEEL ACTION 1 Find gate
LOCK MANUFACTURER Mosler 2 centers for
DATE REMARKS see below 3 wheel #1



L-50 to 70
R-75
L- 7

gates in wheel number one at 51, 57, 63, 69 etc. Gate locations will be used in graph number 4.

(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

FIGURE 9.7 A short graph of wheel number one, determines gate centers.

GRAPH NUMBER 4 (Fig. 9.8)

Graph number four is begun, using information gained in the previous graphs. Wheel number two was parked at right "75" and wheel number three was parked at left "7." Using information gained from graph 3A, the gates were projected around the wheel and penciled into the left margin of the graph sheet. Contact readings were taken at all possible gate locations and a conclusion was drawn that "51" was a possible gate location on wheel number one.

A second conclusion was drawn from the fact that the safe remained locked. One or more of the trial gates was not a true gate.

WHAT-IF ?

After working through all the graphs we find that the lock remains locked. If our contact readings have been accurate and the dialing sequences correct, we will have gained useful information from each graph. Use the information that you have gathered to continue the manipulation. Graph number four has revealed a gate at 51 on wheel number one. Use this information to re-work graph number three. Go back to graph number "3" and redo using 51 on wheel number one.

GRAPH NUMBER 5
NEW INFORMATION

Graph number three was re-worked using "51" on wheel number one and "7" on wheel number three. (See fig. 9.6-b.) The resulting graph revealed a gate at "50" on wheel number two. The safe remained locked.

Using information gained in all previous graphs, continue manipulating. The indication on wheel number two was a 5/8 number change in the contact area. The indication on wheel number three was marginal, but showed up well against all other contact readings. Return to graph number two, using the new gate indications.

GRAPH NUMBER 6
NEW INFORMATION

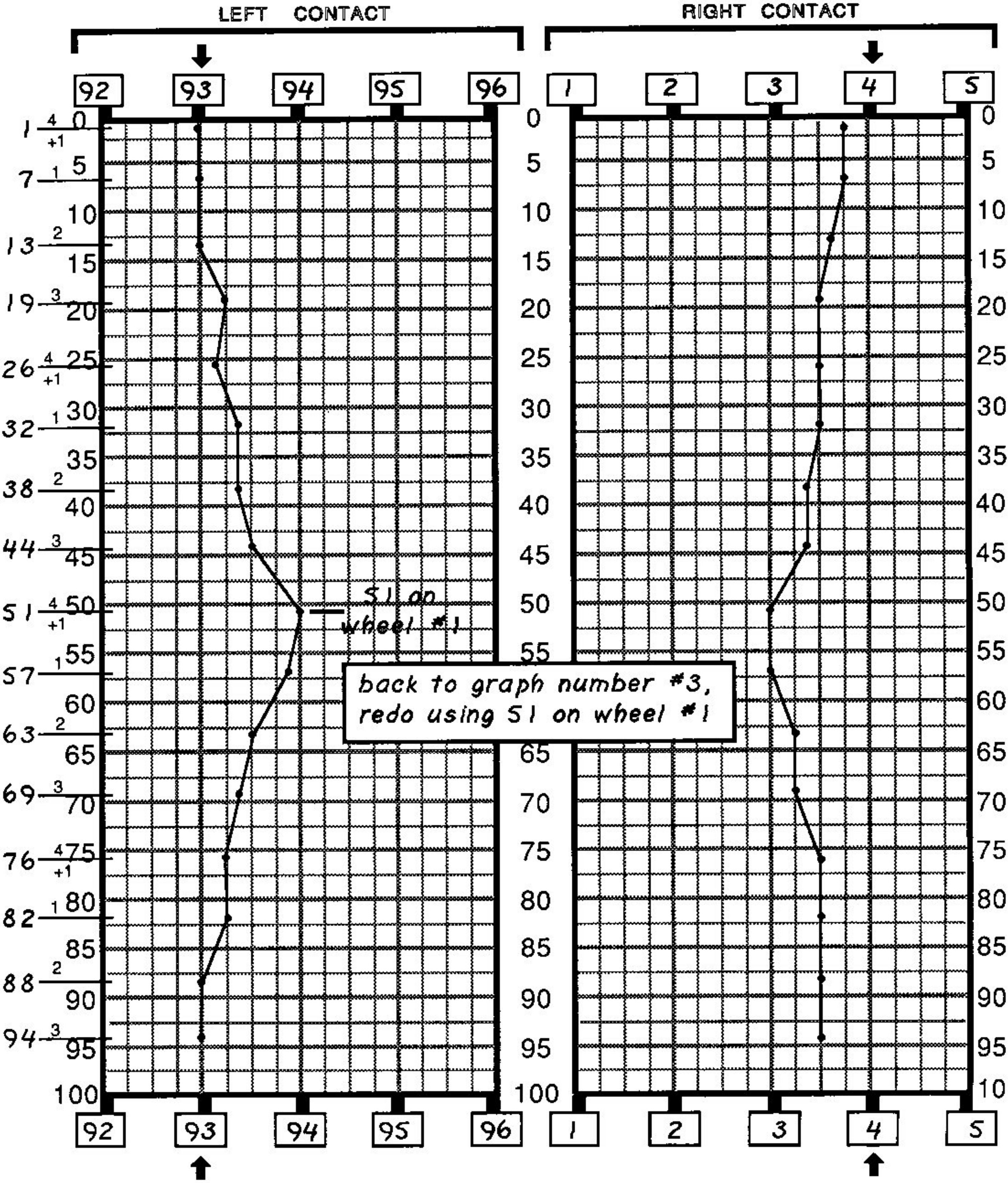
Return to graph number two.(See fig. 9.5b) Using left "51" on wheel number one and right "50" on wheel number two, Wheel number three was graphed around left from "50". The safe was opened at number "88".

The combination was left 50, right 50, left 88. The safe was most probably set to open with only a two number combination and the drop. (i.e., R-50, L-88, RIGHT TO 94 and OPEN)

NOTE:

Once a graph sheet is set up to graph a particular wheel, you may use the graph sheet more than once to re-work that wheel. Save time by not having to re-label the gate locations. Use a colored pencil for the second graph to make it stand out from the first.

COMBINATION LOCK GRAPH NO. 4 WHEEL ACTION 1 around left
LOCK MANUFACTURER Mosler 2 right 75
DATE REMARKS left 50 on wheel #1 3 left 7



51 on wheel #1

back to graph number #3, redo using 51 on wheel #1

(ENTER INITIAL CONTACT POINTS AT ARROWS. NEAREST WHOLE NUMBER ONLY. FILL IN ADJACENT BOXES)

FIGURE 9.8 A graph of wheel number one reveals a gate at 51.

STUDY QUESTIONS

The following questions are to test your understanding of the material covered and reinforce some of the more important points. These questions are to stimulate thought and increase your understanding of the concepts and ideas presented in this and all preceding chapters. Study them carefully.

1. When is parking necessary in a manipulation?

2. What major advantage is gained by parking two wheels and graphing the third? (in a three wheel lock)

3. Why were trial combinations not used during the manipulation described in this chapter?

Refer to figure 9.4, page 113, to answer questions 4 through 6.

4. In the upper portion of the graph sheet is represented a graph. What wheel is being graphed? What information is gained in this graph?

5. Explain why the indications for wheel number one were not sharp enough to give us useful information at this time. Why were the indications in graph 3A (fig. 9.7, page 119) so much better?

6. How is the statement "false gates are actually a friend to the manipulator" true?

What advantage does the manipulator gain by a thorough knowledge of this lock?

7. Along the left margin of graphs 2, 3 and 4 are a series of numbers penciled in.

What significance do these numbers have on the wheel being graphed?

8. How many false gates are present on any given wheel in the Mosler 302 and 402 type lock?

What is the exact numeric displacement of these gates one from another? (A gate appears every (how many)__________ numbers.)

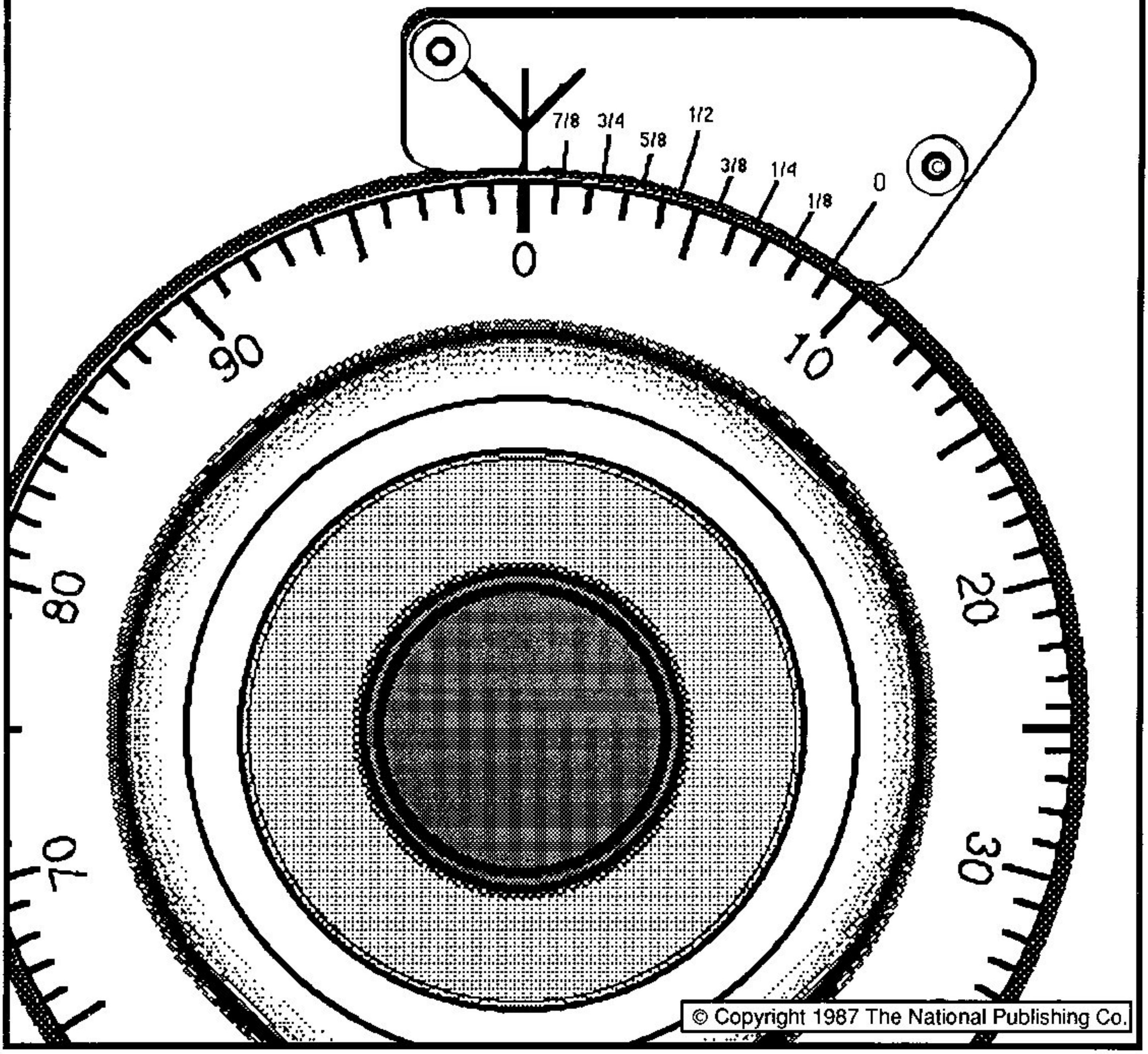
For study question answers, see page 137.

Chapter Ten

The Vernier Scale
An Aid To Manipulation

DIAL VERNIER
AN AID TO MANIPULATION

The vernier scale is introduced. Application of the vernier principle to dial reading is shown.


7/8
3/4
5/8
1/2
3/8
1/4
1/8
0
0
10
90
20
80
30
70

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DIAL VERNIER
AN AID TO MANIPULATION

GOAL

1.Upon completion of this chapter, you will understand the principle of the vernier scale as it applies to the vernier dial.

THE VERNIER SCALE

For those familiar with the vernier caliper, this section will be a review of practice and possibly an insight into what principle will allow us to read a scale or dial in very small increments without eye strain or elaborate measuring equipment.

The vernier principle, when applied to the reading of a safe dial, will allow us to read in eighths as easily as we now read whole numbers.

This method of measuring or dividing known distances into very small parts is credited to the invention of Pierre Vernier in 1631. The principle is not new, nor is it complicated to understand. For reading a safe dial in very small increments accurately, it is truly a natural. All that is required is a little knowledge as to how the vernier is set up and how to read it.

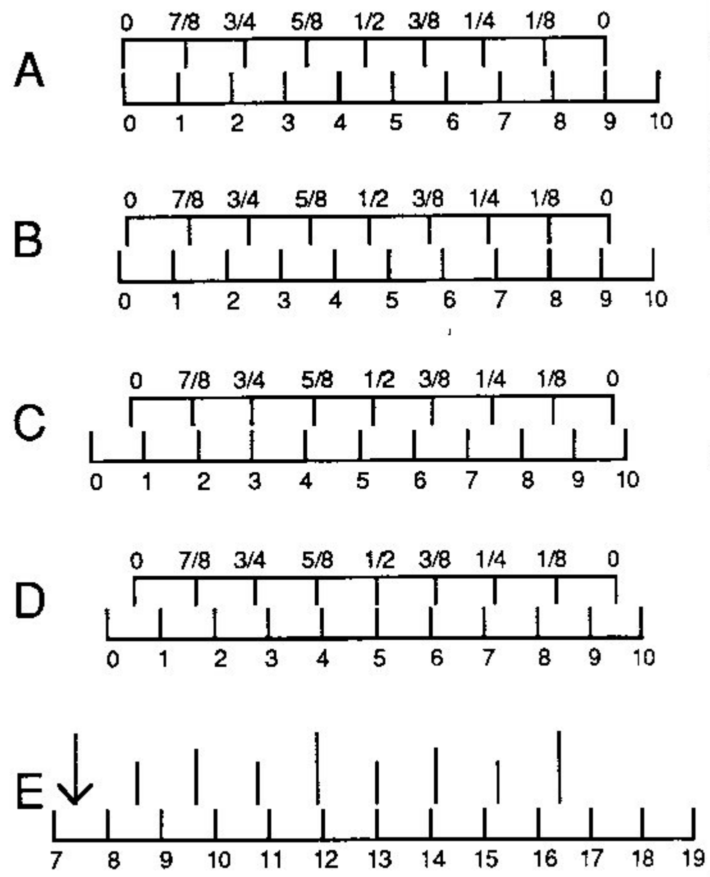


Fig. 10.1

In figure 10.1 at right, illustration "A" shows a scale numbered from "1" to "10". Atop the scale is a vernier scale that will be used to divide the distances between each scale division into eighth division increments. The vernier scale is constructed by marking off a distance one division longer than the desired number of sub increments and dividing that distance equally into the desired number of sub increments. Since our desire was to divide the scale into eighth division increments, we marked off a distance of nine divisions and divided this distance into eight equal parts. If we had wanted to construct a vernier to divide our scale into tenths of a division, we would have marked off a distance of eleven units and divided this distance into ten equal parts. You will note that the divisions of the vernier scale are not true to any scale. These divisions are derived from the given scale but not measured by that scale. Illustration "A" shows the vernier set to zero. In illustration "B" we see the scale has been moved so that the first mark of the "vernier scale" has aligned with a mark on the "true scale". The scale has moved one eighth of a division on the true scale. If the scale were moved another eighth of a division, the second mark on the "vernier scale" would align with a mark on the "true scale". If the scale were moved three quarters of a division on the scale, the sixth mark on the vernier scale (3/4) would align with a mark on the true scale. As you can see in illustration "C", the 3/4 mark on the vernier scale is aligned with a mark on the true scale. The scale has been moved three quarters of a division. Illustration "D" shows the scale at 1/2. By properly reading the vernier, we can see that the 1/2 mark on the vernier has aligned with a mark on the scale. Illustration "E" shows a vernier, as before, but without the fractional helps. Remember that the increments are 1/8 increment marks and are read from right to left. (1/8 - 2/8 or 1/4 - 3/8 - 4/8 or 1/2 - 5/8 etc.) Read the vernier scale indication pictured in illustration "E".

If you read the scale at "7 3/8" you were correct.

You will note that the zero on the vernier scale in illustration "E" is an arrow. This arrow strangely resembles the opening index on a dial ring. Why not wrap the scale around in a circle until the one hundred mark and the zero mark define the same position and flatten the scale down so the numbers are on the outside of the ring and can be read from the front. This sounds like a safe dial doesn't it. If the vernier scale were curved to meet the outside diameter of the dial, it would be possible to read the dial in increments of one eighth of a division. (See fig. 10.2.)

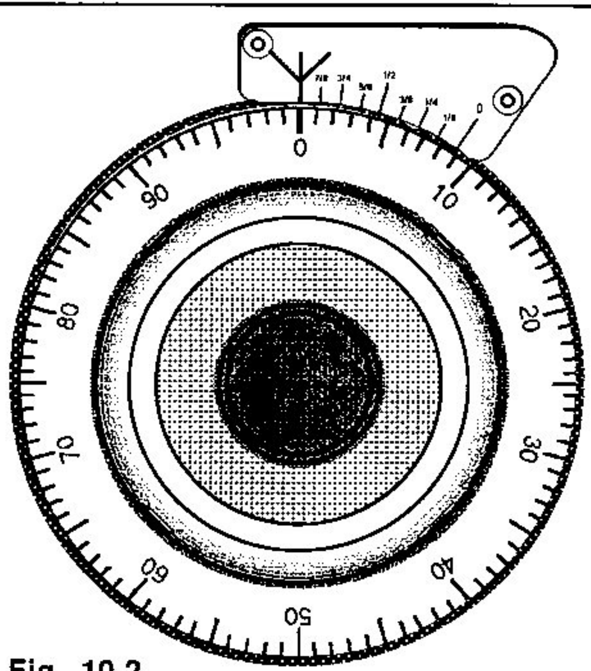


Fig. 10.2

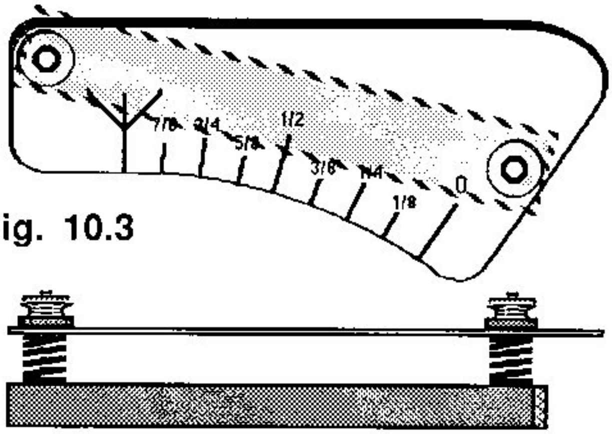


Fig. 10.3

1 RUBBER MAGNET
2 8-32 X 1" FLAT HD. MACH. SCREW
2 8-32 THUMB NUTS
2 SPRINGS

DRILL AND COUNTERSINK SCREWS THROUGH MAGNET. EPOXY SCREWS IN PLACE. ASSEMBLE AS SHOWN. FOR THIN DIAL RINGS, ELIMINATE SPRINGS.

Figure 10.3 shows the construction of a vernier scale for a safe dial. The scale is mounted by a magnetic strip to the safe door, and adjustable for heigth to allow it to be placed over the dial ring and close to the safe dial. With this device, it is possible to accurately read eighth numbers.

Though this tool works quite well, but it is much easier to construct your own vernier right on the dial ring. By applying a self adhesive white label to the dial ring, in the same area as the tool shown, you can easily mark off a very useable vernier scale using the knowledge gained in this chapter.

The vernier should be constructed using the portion of the dial you will be using during the manipulation (at the contact area), as some dials are not geometrically accurate in the division of the dial. (i.e., The distance between the divisions of the dial is not uniform around the dial.)

Try this little trick on your next manipulation. It will increase your speed by reducing your squint time.

QUESTIONS

The following questions are to test your understanding of the material covered and reinforce some of the more important points.

1. When was the Vernier scale invented, and by whom?

2. If you wanted to construct a Vernier scale to read in tenths of a division, you would mark off a distance of how many units on the dial?

3. Why is it best to construct a Vernier on a self adhesive label, right on the dial ring?

4. Construct a Vernier scale on your cut away lock to read in eighths of a division. Take contact readings across an indicating area of the wheel pack using the new scale.

   Did you find that using a scale was easier than judging eighths using only the opening index?

For study question answers, see page 137.

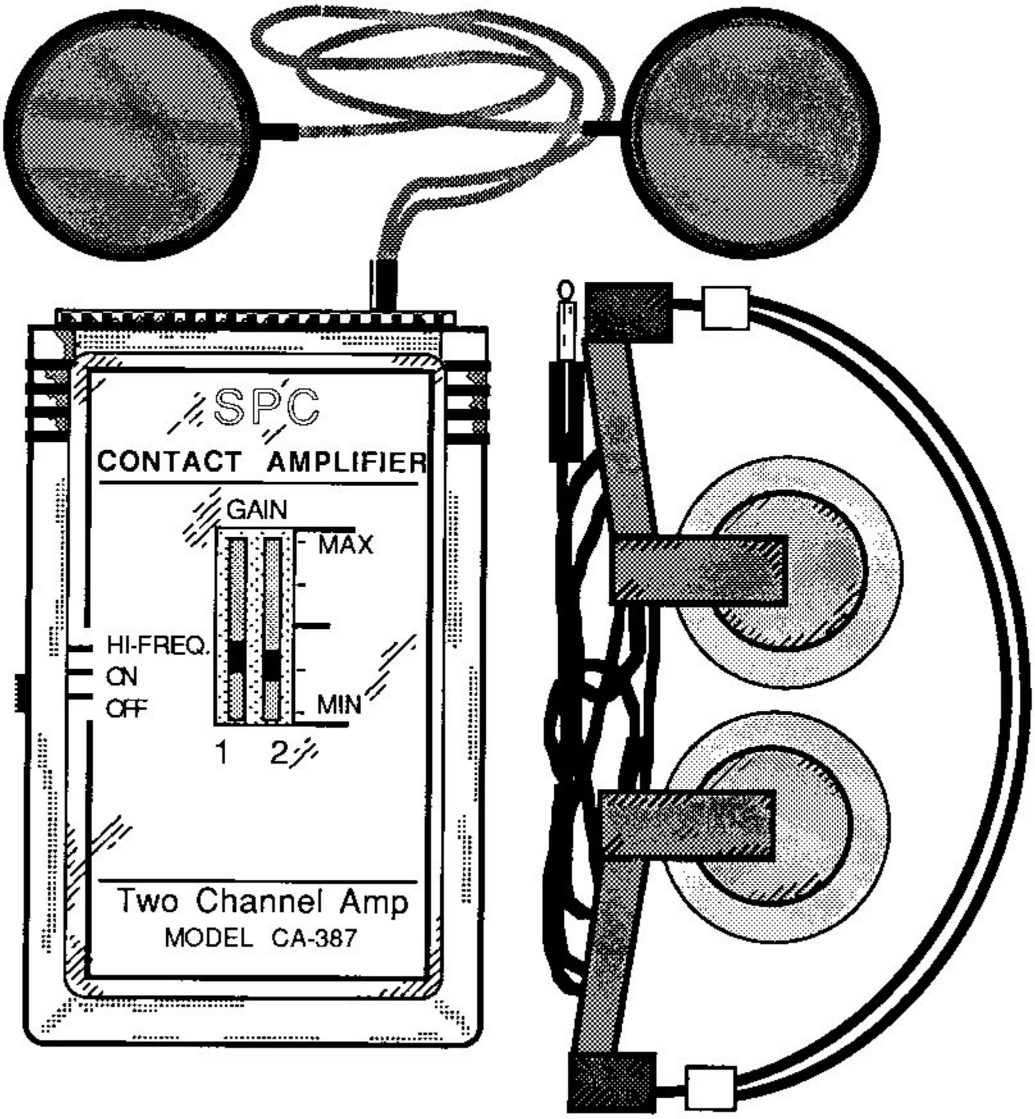
NOTES

Chapter Eleven

The Safe Lock Amplifier An Aid To Manipulation

THE SAFE LOCK AMPLIFIER AN AID TO MANIPULATION

Introduction to the safe lock amplifier.


SPC
CONTACT AMPLIFIER
GAIN
MAX
HI-FREQ.
ON
OFF
MIN
1
2
Two Channel Amp
MODEL CA-387

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THE SAFE LOCK AMPLIFIER AN AID TO MANIPULATION

GOAL:

1. Upon completion of this chapter, you will understand the need for and proper use of the safe lock amplifier.

AMPLIFIERS

There are many safe lock amplifiers on the market. These amplifiers will allow the manipulator to more clearly define the contact points, count the number of wheels in the lock, listen for drive pin malfunctions, hear gates as they pass under the fence on some gravity fence type locks and listen to conversations through furnace and ventilating ducts. The last use of the amplifier is not recommended. Though it may be the most fun, it is the most dangerous.

The best amplifiers offer a very high gain. Some offer degrees of filtering, to allow the manipulator to mask unwanted noise. Most current amplifiers are transistor type. This allows them to be light, battery operated and very portable. The microphones should be magnetic, to be easily placed on the safe door. The headphones should be light and comfortable.

THE CA-387

The CA-387 contact amplifier, designed and manufactured by the author, incorporates the most needed features of a safe amplifier, without being complicated to operate. Figure 11.1 shows the CA-387 contact amplifier. The microphones and amplifier are magnetically mounted to the face of the safe for hands-free operation. Amplifier gain controls set the volume at the headphones. The slide switch on the left side of the unit performs two functions. First it acts as a main power switch for the amplifier. Secondly it enables the high frequency boost and low frequency filtering circuits.

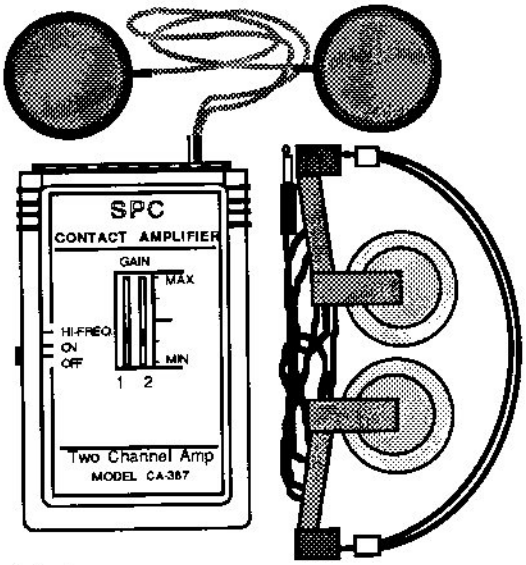

Fig. 11.1

The low frequency filtering circuits act to block most of the annoying background noises experienced with safe lock amplifiers. Noises such as footsteps, doors opening and closing, furnace blowers and voices in the room are filtered out.

The high frequency boost circuit brings out the high frequency safe sounds (metal to metal clicks) allowing the manipulator to pinpoint contact point locations and wheel pickup points with accuracy and dependability.

This amplifier will allow the master safesmith to define the exact contact points more accurately. Manipulation of safes with very soft contact points is much easier with this amplifier.

(The gravity fence Victor safes will sometimes give one of the combination numbers by just listening to the wheel pack and counting turns.)

As the lighted magnifier allows the manipulator to see the indications more clearly, the safe lock amplifier allows the manipulator to hear indications more clearly. Indications that might otherwise be overlooked or misinterpreted, come through loud and clear. Confidence in your contact readings will allow you to manipulate more accurately and with greater speed.

The safe lock amplifier is not an absolute necessity, but it can be the edge that will allow you to manipulate a safe that would otherwise defy your best efforts. All locks indicate, some just speak softer than others.

PLACEMENT OF MICROPHONES

The magnetic microphones should be placed as close to the lock as possible. Since the vibrations of the lever nose contacting the drive cam are coupled through the mounting screws of the lock to the door, place the magnetic microphones at the approximate locations of the lock mounting screws. For gravity fence type locks, place the microphones at the drop-in point. (For the older Yale gravity type locks, this is at about 50 on the dial, for the Victor locks it is about zero.)

WHAT ARE WE LISTENING FOR ?

- Contact points.
- Wheel pick up points and number of wheels.
- Gate locations, in certain locks.

NOTES

CHAPTER QUESTION KEY

The following are answers to chapter questions presented at the end of each chapter. They are presented for your convenience and are keyed to page refferences that will lead you to a more complete understanding of the material presented in this book.

CHAPTER ONE

1. Drive pins are the fixed or moveable pins found on the drive cam and combination wheels that transmit motion from the drive cam to each combination wheel. It is the action of the drive pins that allows us to independantly position each wheel within the lock.
See page 6. Also chapter four, fixed drive pin locks.

2. Flys are moveable drive pins. A fly is a drive pin that is free to move around the combination wheel by their width plus one half of the width of the drive pin.
See page 6.

3. Screw change wheels and hole change wheels will normally not have flys.
See page 6.

4. The wheel lock may logically be divided into three interactive groups, they are the driver, wheel pack and bolt.
See page 8.

5. The combination wheel closest to the drive cam will always contain the last number of the combination. In this case the third number.
See page 9.

6. False
The combination wheel farthest from the drive cam will always contain the first number of the combination. See page 9.

7. The fence lever and bolt group may be divided into four major types. These are the spring loaded fence, the friction fence, the gravity fence and the direct entry type fence.

8. A contact point is the point at which the nose of the lever contacts the sides of the drive cam gate. Some locks will show two contact points, they are the left and right contact points of the drive cam. By recording their position on the dial, it is possible to find the distance between the left and right contact points. The distance between the left and right contact points will be called the contact area. Changes in the contact area will reflect the diameter of the wheel pack. See page 11.

9. The Yale friction fence lock will give only one contact point. See page 12.

10. You have encountered a Yale friction fence type lock. See page 12.

11. You have encountered a direct entry type lock. See page 14.

12. It is the function of the fence to "try" the wheel pack, determining whether or not all gates have been properly positioned to allow the lock to be opened, or the bolt to be retracted. See page 11.

13. The lever performs two major functions in a spring loaded fence type lock. They are to properly position the fence over the wheel pack, and to retract the lock bolt. See page 11.

14. It is the function of the driver to accurately transmit motion and positional information to the wheel pack. The driver positions all wheels within the lock, and in some cases also extends and retracts the lock bolt or door bolts.
See page 8.

15.The change index is used to properly position the combination wheels of a key change type lock to accept a change key.

See page 5.

CHAPTER TWO

1. Left. See page 20.
2. The contact area is the distance between the left and right contact points. See page 20.
3. A decrease in the width of the contact area is an indication of a decrease in the outside diameter of the wheel pack. See page 22.
4. See pages 20 & 21.
5. See page 22.
6. Not all gates will indicate as they pass under the fence. The wheels may indicate in any order, but they will most usually indicate one at a time. (i.e., Wheel number three must have its gate positioned under the fence before wheel number two will give indication. or Wheel number two must be properly positioned before wheel number one will indicate. etc.) The exercise on your lock will show which wheel indicates first.
7. The graphs are of the left and right contact points. See page 25.
8. This is the nearest "whole number" to the actual contact point. See page 25.
9. False. See page 27.
10. This is an exercise, and is designed to give you experience in reading and recording contact points. The questions are to direct your attention to specific points to watch. Though there is no answer to this question, but it is by far the most important exercise in this chapter. Follow the wheel action carefully as you do this exercise.

CHAPTER THREE

1. Follow the steps in the flow chart to determin why no wheels are picking up. This question directs your attention to the possibility that a particular problem may not necessarily require the lock to be drilled. The described problem could be solved by pulling out on the dial to engage the drive pins if the problem is end play. See page 29.
2. The first graphing sequence should be an all wheels left evolution for a three wheel lock. (all wheels right for a four wheel lock) See page 33.
3. The manipulation should be performed by pulling out on the dial as each contact point is taken. See page 34.
4. False.

   Accuracy will open more safes than speed.
5. Smallest, narrow. See page 37.
6. Taking contact readings through the area of best indication every number will give a better or more accurate picture of the suspected gate. You must define the exact limits of the gate indication before a center can be accurately determined. See pages 37 and 39.
7. The left and right contact readings will rarely be identical. One or the other will give a better indication of the gate. The gate centers may not be the same. Averaging the two will give a more accurate location to the GATE CENTER. See page 39.
8. Test. See pages 39 and 40.
9. Combination number two tests wheel number two. See page 40.
10. Because of high and low spots in any given wheel, running a set of high and low test combinations will greatly increase the accuracy of your findings. Chosing the indicating wheel is one of the most important steps in a manipulation. If the whong wheel is determined to be the indicating wheel, all further effort will be wasted.
11. We speak of using a known gate as a

window in the fact that the fence will penetrate the gate of the known wheel and be allowed to rest on the remaining wheels. We must allow the fence to interrogate the wheels in whatever order they present themselves.

If in the first graph of the wheel pack, we determine the gate location of wheel number three, we must use this knowledge to return wheel number three to its gate location each time a contact reading is taken on the remaining wheels. Wheel number three would otherwise mask any indications of the remaining wheels. See page 41.

12. By assigning a direction to a suspected gate, we avoid problems caused by wear in the drive pins and fixed drive pin "spread" misaligning the combination wheels during the trial combination steps. See chapter four, on fixed drive pins.

13. Because the gate in wheel number three was known, it was not necessary to test wheel number three. See page 45.

14. Wheel number one at RIGHT 50
 Wheel number two at RIGHT 50
 Wheel number three at LEFT 10

15. No. Anything is possible but not everything is economical. Time required and level of technical proficiency necessary will determine what locks (1) are worth manipulating and (2) can be manipulated profitably. About 10% of the safes I am called to open, will either be drilled or opened by another. "If you can't make money at a particular job, walk away from it."

16. Graph "C" shows the greatest "rate of change." It changes vertically one full division, in one division of horizontal movement.

CHAPTER FOUR

1. Screw change wheel, pin change wheel or hole change wheel and no change wheel are all examples of fixed drive pin wheels.
See pages 55 and 56.

2. See page 56.

3. Twenty (20) different combinations are possible. The spread between the numbers of the combination do not change.

By adding multiples of five (5) to the first combination, all possible combinations can be worked out.

4. As the width of the drive pins increases, the spread between the adjacent wheel numbers increases. A zone of numbers not available for use in the combination increases as the drive pin width increases. This could be called the forbidden or impossible zone, as numbers within this area can not be used in the combination.

Figures 4.2 & 4.3 (page 56) illustrate an area from 5 to 87 that can not be used on wheel number three of the lock shown. The eighteen numbers in the forbidden zone, may not be used on wheel number three, if wheel number one is to be positioned as shown.

5. See page 57.

6. Because the direction of placement of the offending wheel may be reversed. See page 58.

7. The purpose of the special trial combination routine is to place two adjacent wheels using the same direction of wheel movement. See page 58.

8. We see at the beginning of the manipulation that the lock uses fixed drive pins. The spread is about 20 on the dial. Directional placement of the wheels for this lock will have to be considered as the trial combinations are

begun. A forbidden zone of five numbers will exist either side of a known gate on adjacent wheels. A ten number zone between wheels one and three. Probably a pin change type lock.

9. Extend the graph another ten numbers in the same direction. Extend the graph until the gate is found. See page 60, rule number 2.

10. Leads. See page 59.

11. Subtract. See page 60.

12. False. The spread of the drive pins can cause the indicated gate to be almost anywhere.

13. 27

14.

A. Wheel number two picked up an began moving around left. The contact area changed because the gate of wheel number two was displaced.

B. The graph from 5 to 32 represents wheel number two.

C. Wheel number three picked up at some number left of 32. Possibly 20.

D. 2. Begin the graph left of the last number by approximately the width of the forbidden zone. Feel for the wheel to pick up, and begin the graph there.

CHAPTER FIVE

1. No contact points are present with right rotation of the dial.

2. The wheel illustrations on the test combination sheets graphically show which wheel is being displaced from the gate center indication.

3. The addition of an extra wheel, required an extra step in each combination, the addition of an extra set of combinations to test wheel number four and an extra row of test information in the information block at the top of the sheet. See page 70.

4. Follow wheel action, page 70.

5. When the wheel that is indicating the gate is tested, the good indication is lost.

6. Use information gained to this point to continue the manipulation. Refer to items 24 through 31, pages 78 and 79.

CHAPTER SIX

1. The action of the bolt-works spring retracts the door bolts of the Sentry floor safe.

2. The text suggests a 2 1/2 number graphing sequence, which would require 40 contact readings to graph 360° of wheel rotation. I have had good success with a 5 number graphing sequence, requiring only 20 contact readings.

3. The lock shown would have 9 possible combination changes.

All the combinations would have the same drop-in, and the spread between the first and second numbers would be the same.

If we had the original combination, we could add multiples of ten to the old combination to find the new or unknown combination. (Only the first two numbers of the combination will change.)

4. 35 and 75 See page 84.

5. The phillips screws that attach the handle ends to the door pass through the door.

CHAPTER SEVEN

1. See page 91.

2. By holding the turning torque constant over the course of the manipulation, we are assured that all contact readings will be taken with the same pressure (the fence trying the wheel pack)on the wheel pack. Too much torque

will cause the fence to warp, the wheel post to spring or the handle to begin to move on the handle shaft. Finesse not force is the key here.

3. The drive cam gate is straight sided. Entry of the fence into the drive cam gate will not cause the contact points to vary with the amount of penetration.

4. Exercise.

5. The only reason to drill this safe is if a malfunction in the lock prevents the bolts from being withdrawn. See page 91. (Side drill, in line with the handle, 1 5/8" back from the face of the door. Punch the bolt back using a pin punch.)

CHAPTER EIGHT

1.

A. A raised ridge in the lock cover prevents the drive cam from being pushed down at any position but the drop-in. See page95.

B. The fence spring exerts force on the fence plate, causing the fence to try the wheel pack as the drive cam moves down.

2. Scroll plate. See fig. 8.2, page 96.

3. Illustration "C". See page 97.

4. This safe gives indication in the verticle direction. See pages 97 and 98.

5. b. All wheels left.

6. .001" (one thousandth of an inch)

7. a. moving down (Indication changes toward the left side of the graph.)

CHAPTER NINE

1. Parking is necessary when an all wheels graph either yields no definate indications, or yields such a variation of indications that finding a gate is impossible. See page 108.

2. The advantage of graphing one wheel at a time is that the graph will reflect the profile of only one wheel. This eliminates some of the effects of masking and overlaping wheel indications.

3. Trial combinations are not necessary when the graph represents the outline of only one wheel.

4. In the upper portion of this graph sheet, wheel number three is being graphed.

The locations of three gates are found in this step of the manipulation. By this step, we are able to project all possible gate locations of this wheel. See page 112.

5. In graph 1A, wheel number two was masking the gate locations in wheel number one. In graph 3A, wheel number two is placed at a point that allows the fence to rest on wheel number one. (a lower false gate) The indication of wheel number one is read using the gate on wheel number two as a window.

6. If we know that there are only sixteen possible locations for a gate in a particular wheel, we need only take sixteen contact readings of that wheel to find a gate. This allows the graphing procedure to skip 24 contact readings and most of the GATE CENTER extra contact readings.

7. These numbers locate the sixteen possible gate locations for the wheel being graphed.

8. There are fifteen false gates in every Mosler combination wheel. One is a true gate.

A gate appears every 6 1/4 numbers on the dial. See page 114. (**Study the counting procedure carefully.1 - 2 - 3 - 4+1**)

CHAPTER TEN

1. The Vernier scale was invented in 1631 by Pierre Vernier.

2. 11 units. See page 125.

3. Most dial rings are not geometrically

correct. The distances between graduations on the dial will not be constant around the dial.

4. This is an exercise to illustrate the principle presented in this chapter.

CHAPTER ELEVEN

This chapter is included for your information only. No questions were given.

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